Chemical Engineering

A McGRAW-HILL PUBLICATION

NOVEMBER 30, 1959

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What's New at Low, Low Temperatures

A Rational Method of Plant Layout

How to Stop Inventory Cheating

COMPLETE CONTENTS PAGE THREE

The Shell chemicals listed below are sources of many important commercial products.

Take a closer look in a different light...

A closer look at familiar things in a different light often helps us recognize many interesting and attractive features. This close-up photograph of a diamond in a red light gives us a dramatic new perspective on this familiar gem.

The Shell chemicals in the column at the right may be familiar to you. But a closer look in a different "light" may lead to new and profitable products for your company.

Each of the listed chemicals is used in manufacturing many other important industrial materials. Their reactivity leads to an extensive and growing chemistry that is well worth your investigation. All listed products are available in commercial quantities.

Your Shell Chemical representative will gladly help you take a closer look at the many practical applications of these or other Shell chemicals. Samples and technical literature are available at your request.

Allyl Alcohol
Allyl Chloride
Bisphenol A
Dimethyl Ketone
Epichlorohydrin
Ethyl Amyl Ketone
Hexylene Glycol
Hydrogen Peroxide (including 90 per cent)
Methyl Isobutyl Carbinol

SHELL CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION

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IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited, Montreal • Toronto • Vancouver

SHELL

Get CF&I-Claymont Heads . . .

in many metals, shapes and sizes

To heavy equipment fabricators and users, the CF&I giant steelman stands for the many types of steel plate and plate products manufactured in our Claymont plant. One of these quality products is CF&I-Claymont Heads—produced from blast furnace to finished product in CF&I's own plants. Claymont Heads are available in all these metals, shapes and sizes:

Steels—carbon, alloy, stainless, stainless-clad

Other Metals—aluminum alloys, brass, bronze, copper, Hastelloy, Inconel, Monel, other metals supplied by customers

Shapes—standard and ASME flanged and dished, conical, elliptical, hemispherical and special shapes as required

Diameters—up to 19 feet (spun) or 10 feet (pressed)

Gages—up to 6 inches

If you fabricate or use tank cars, pressure vessels, processing equipment, or any other equipment that requires heads, order from Claymont. Many common head shapes and sizes, in carbon steel, are stocked for quick delivery at CF&I warehouses located coast-to-coast. 6971

CF&I-CLAYMONT PRODUCTS: Carbon Steel Plates • Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Clay-Loy High Strength Low Alloy Steel Plates • Flanged and Dished Heads • Manhole Fittings and Covers • Fabricated Steel Plate Products • Large Diameter API Pipe

Claymont Steel Products

THE COLORADO FUEL AND IRON CORPORATION

CF&I STEEL

In the West: **THE COLORADO FUEL AND IRON CORPORATION**—Albuquerque • Amarillo • Billings • Boise • Butte • Denver • El Paso • Farmington (N. M.) • Ft. Worth • Houston Kansas City • Lincoln • Los Angeles • Oakland • Odessa • Oklahoma City • Phoenix • Portland (Ore.) • Pueblo • Salt Lake City • San Francisco • San Leandro • Seattle Spokane • Tulsa • Wichita • *In the East:* **WICKWIRE SPENCER STEEL DIVISION**—Atlanta • Boston • Buffalo • Chicago • Detroit • New Orleans • New York • Philadelphia

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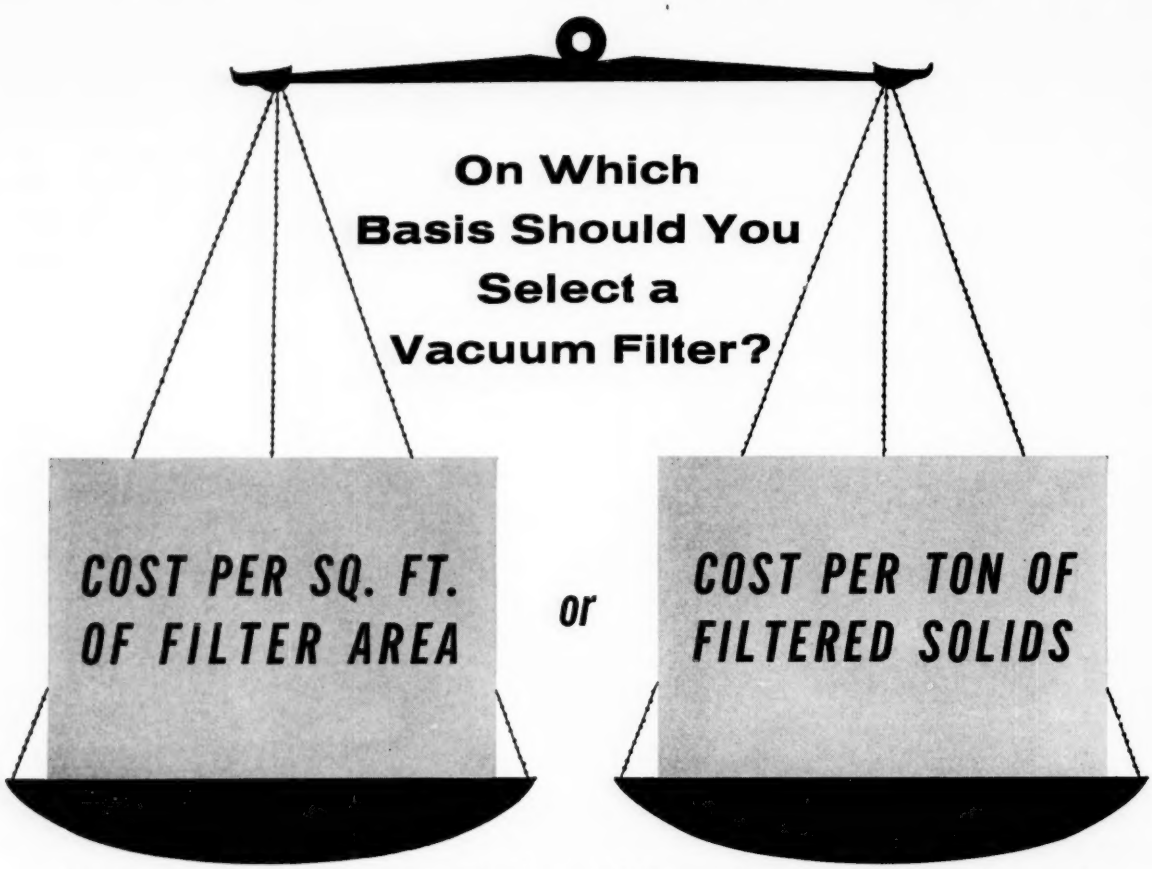


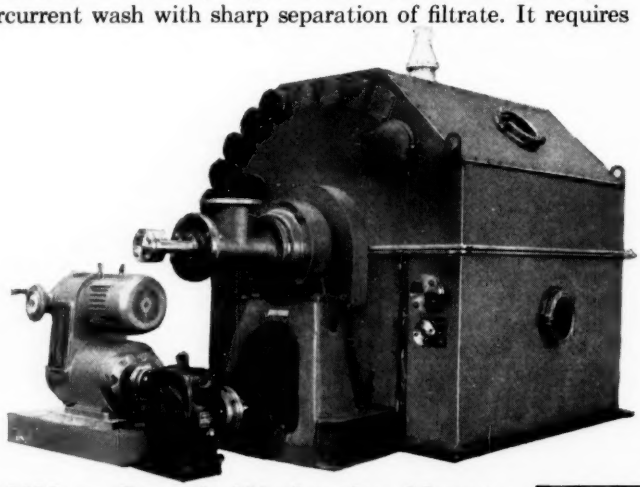
Are you aware that the Bird-Young Filter has such high capacity per square foot of filter area it often does the work of ordinary drum filters with more than twice its filter area?

Which is the better buy?

And which saves filter cloth expense and maintenance?

With the Bird-Young's unique design and construction you get several bonuses besides. It provides super-efficient, multistage, countercurrent wash with sharp separation of filtrate. It requires no filtrate receivers or auxiliaries other than pumps. It takes up far less space. Totally enclosed operation is readily effected with this smaller unit. Exhausted air and vapor can be returned, so volatile solvents do not require expensive recovery equipment.

Before you invest in vacuum filtration find out what the Bird-Young can do — how much it can save. The Bird Research and Development Center offers dependable pilot-scale test data



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The BIRD-YOUNG VACUUM FILTER

November 30, 1959 **Chemical Engineering** Vol. 66 No. 24

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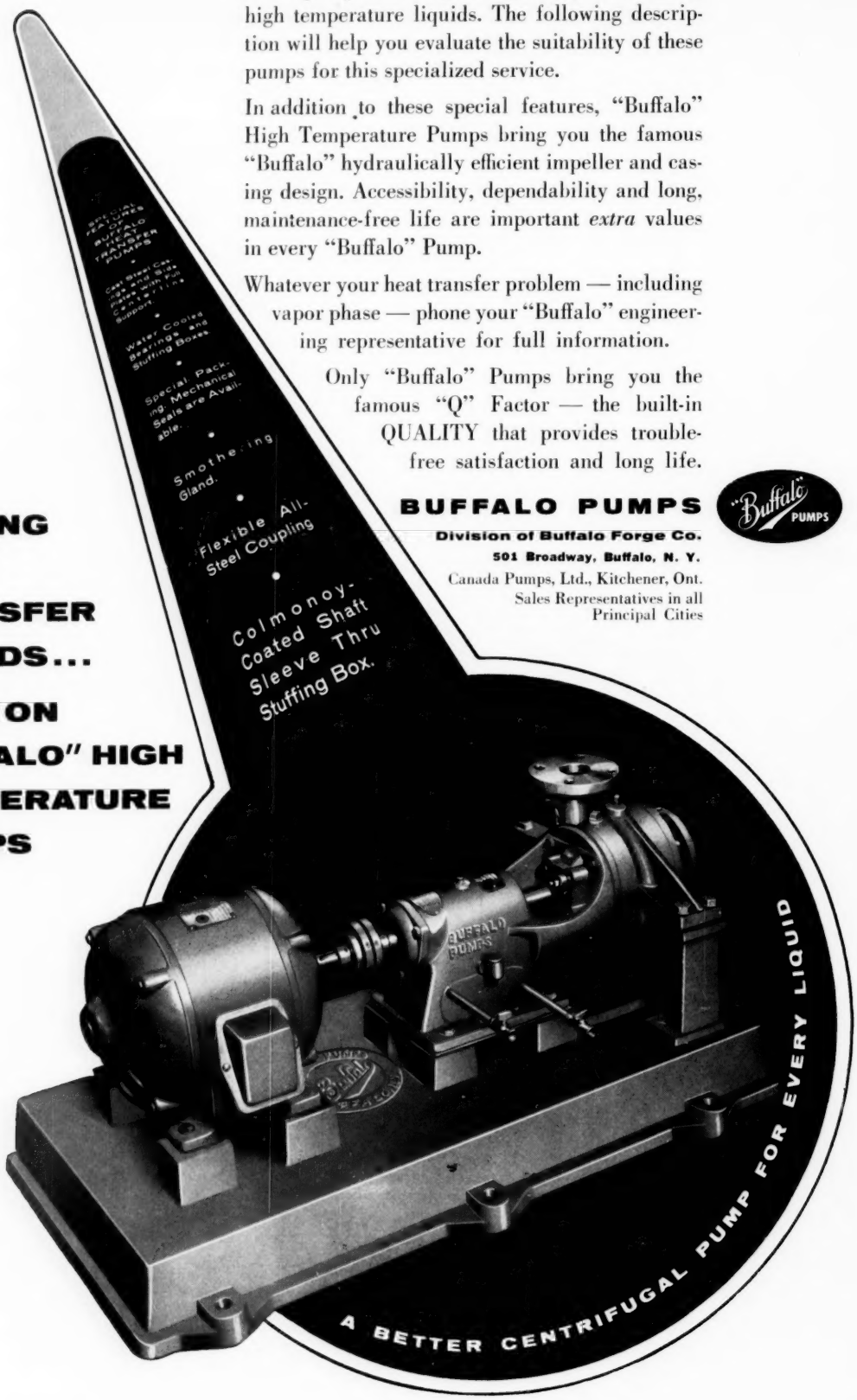
RELY ON "BUFFALO" HIGH TEMPERATURE PUMPS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A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

These pumps are designed especially for handling high temperature liquids. The following description will help you evaluate the suitability of these pumps for this specialized service.

In addition to these special features, "Buffalo" High Temperature Pumps bring you the famous "Buffalo" hydraulically efficient impeller and casing design. Accessibility, dependability and long, maintenance-free life are important *extra* values in every "Buffalo" Pump.

Whatever your heat transfer problem — including vapor phase — phone your "Buffalo" engineering representative for full information.

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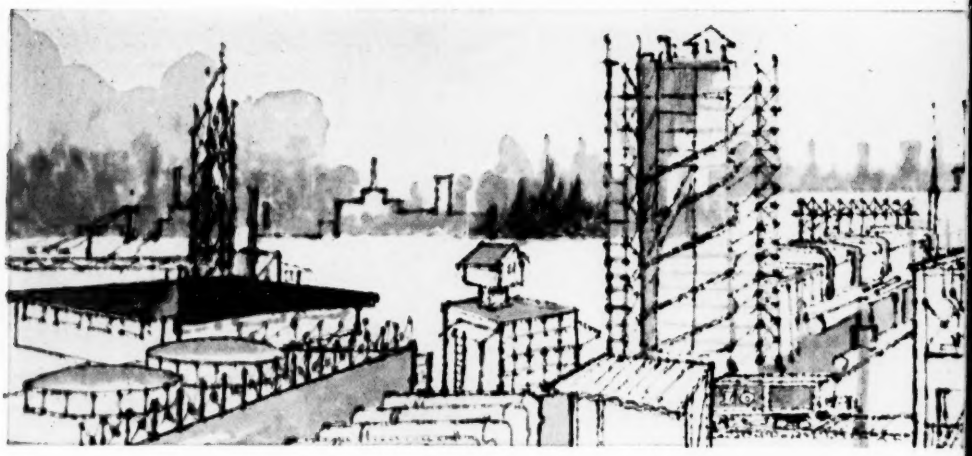
ENGINEERING AT ITS BEST



WHAT YOU SHOULD EXPECT

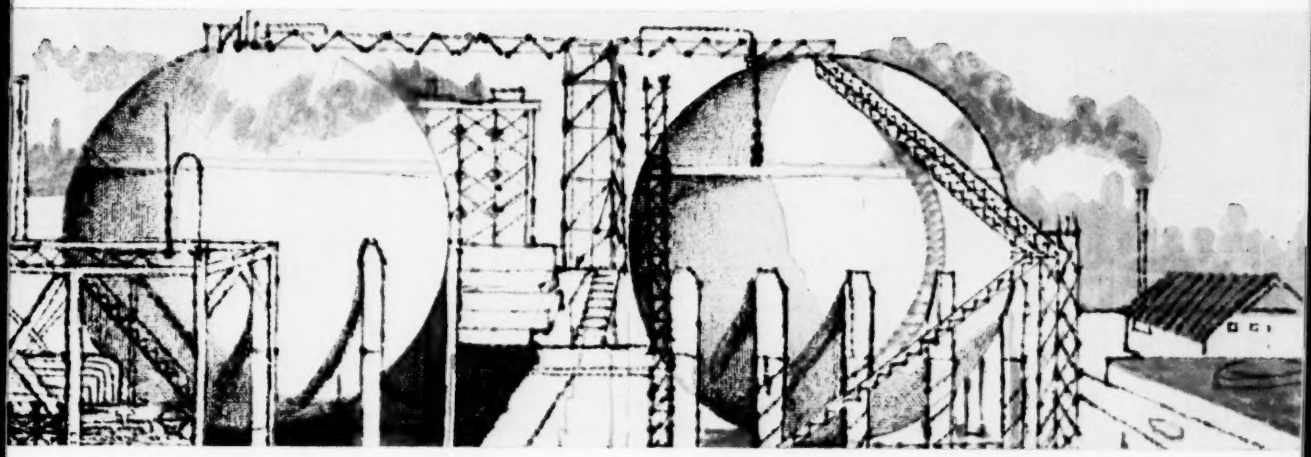
When you go to an engineering firm for help in the design and construction of a new plant, or the expansion of existing facilities, you have a right to expect certain basic standards from that firm. They should have EXPERIENCE, for only with past experience can you minimize the number of new problems which will arise on any new project. Such experience, however, should be tempered with FLEXIBILITY, CREATIVITY and VISION. Some companies are experienced beyond measure at building plants from designs more than 25 years old. In the highly competitive years ahead, such plants could prove economically unsound. You owe it to your company's future to select a firm which has proven its ability to provide the newest and the best in process engineering.

For almost half a century, CHEMICO has maintained a reputation for progressive and imaginative process design and improvement. This proven "know-how" is available to firms in the chemical and petrochemical fields requiring any and all types of engineering and construction services.

WAYS OF WORKING WITH THE CLIENT

A recently completed petrochemical plant offers the best example of the several ways in which CHEMICO is prepared to work with its clients. This huge complex was designed to produce acetylene derivatives, and included processes for producing a wide range of basic chemicals. The ammonia, sulfuric acid and ammonium sulfate sections of this plant were based on *Chemico's own proprietary processes*. The designs for the acrylonitrile and hydrogen cyanide units were based on processes developed in the *client's own pilot plant*. For the acetylene plant, CHEMICO *obtained a license* from BASF in Germany for their patented production-proven process. The oxygen plant was designed by the Linde Company of Germany on a *sub-contract basis*. CHEMICO's Construction Department was responsible for erection of all the plants, and CHEMICO's Industrial Projects Department supervised, coordinated and controlled the entire project.

CHEMICO is always prepared to provide its services to clients on any or all of the bases indicated above. For clients with processes of their own, CHEMICO's Industrial Projects Department will engineer and construct plants, starting at any stage of development. CHEMICO's own laboratories and pilot plant are available, if desired, for process development and improvement work on a contract research basis. If the process to be employed has already undergone pilot stage testing, CHEMICO will design the most economic and efficient commercial scale operation. In such a case, the client can be sure that CHEMICO will call on the services of outstanding engineers and technical personnel with experience similar, or related to the unit operations which are to be designed, engineered and constructed. In addition, the client can be assured that CHEMICO, as an independent engineering organization, will undertake such activities in the framework of a completely confidential relationship,



with all necessary safeguards for protecting the client's competitive position in regard to trade secrets and research developments.

In the case of clients who want plants to produce products for which neither CHEMICO nor the client has a process, CHEMICO, through its Industrial Projects Department, will obtain licenses from whatever source possible for production-proven process designs which will enable the engineering and construction of the desired plant.

Very often CHEMICO's drafting force as well as its specialists in civil engineering, mechanical engineering, electrical engineering and other service engineering capacities can be made available to clients on an individual contract basis. CHEMICO's construction organization, made up of a permanent force of highly experienced construction superintendents, is prepared to undertake a wide range of erection projects related to the process industries.

CONTRACT ARRANGEMENTS

CHEMICO offers its clients a wide choice in the type of contract under which each individual project is to be handled. Among the more common arrangements—although by no means the only ones available—are the following:

Cost Plus Fixed Fee: Under this type of contract, CHEMICO's fee and overhead charge for engineering, construction and related services is decided by mutual agreement, and the client is billed at direct cost for any and all expenses incurred by CHEMICO to complete the client's project.

Lump Sum: At the client's request, CHEMICO submits a firm estimate containing a specific price for which CHEMICO will undertake to complete the client's project.

Guaranteed Maximum: Under this type of contract, CHEMICO will set a maximum cost to the client for an individual project. If the cost of the project falls below the maximum figure, all savings will be divided between CHEMICO and the client on the basis of a prearranged rate.

Fixed Price Equipment Supply: Under this type of contract, the client gets the benefit of CHEMICO's design, engineering, purchasing and expediting services, but is free to make his own arrangements for the construction of his project.

Basic Design and Construction Supervision: This type of arrangement has proved extremely useful in dealing with clients outside the United States. Ordinarily, under a contract of this sort, CHEMICO provides the basic engineering for a project, and the client makes other arrangements for the detailed drawings and construction. CHEMICO then supervises construction and sees the project through start-up operations.

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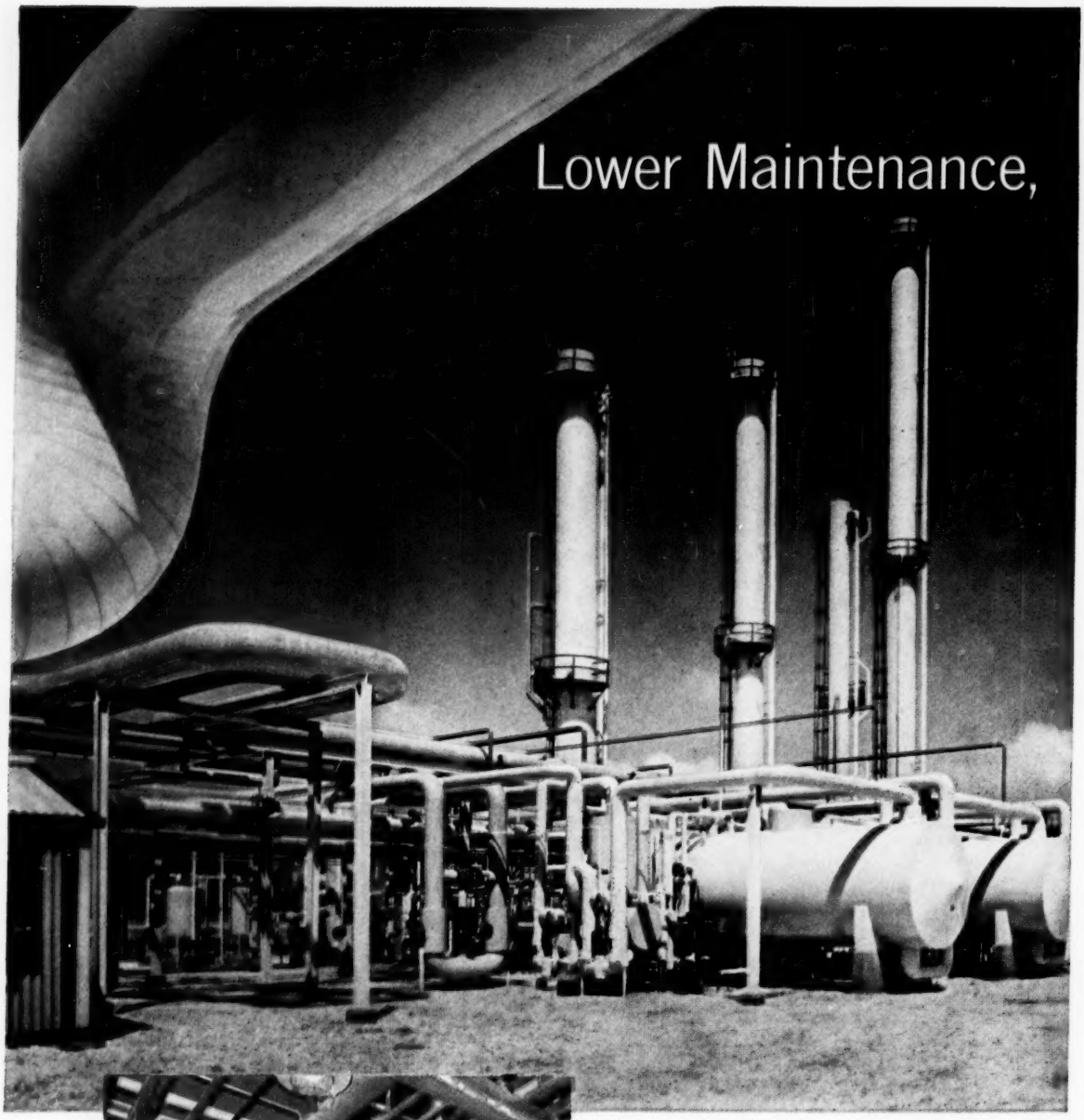
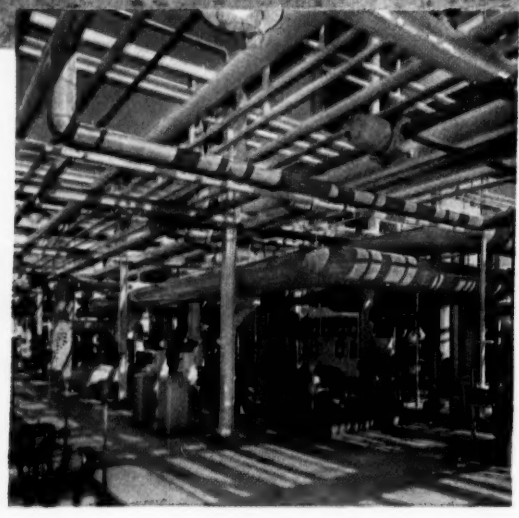




The Finest Products
Made with Aluminum
are made with
REYNOLDS ALUMINUM

Reynolds Colorweld Aluminum jacketing adds color and protection on vessels and piping at Superior Oil's Lowry gas processing plant. Colorweld's tough enamel finish eliminates site painting, outlasts two or three ordinary paint jobs.

Lasting Protection

...and COLOR WITHOUT PAINTING!

Superior Oil Company Lowers Costs, Beautifies Plant With Pre-enameled Jacketing of Reynolds Colorweld Aluminum

TRADE-MARK

Superior Oil has installed jacketing made of Reynolds Aluminum on the process vessels and pipe lines at its new Lowry gas processing plant near Lake Arthur, La. But this is aluminum jacketing with the big *plus*. It's made with Reynolds Colorweld—*pre-painted* aluminum for added beauty and lower maintenance.

With Colorweld, Superior gets the durability, low-maintenance and corrosion-resistant protection of aluminum jacketing, with all its excellent heat-reflecting and insulating properties. *And* it gets the added beauty and protection of a permanent baked enamel finish, *without* the expense of site painting.

Hudson Engineering Corporation, Houston, designed and built the plant. Fuller-Austin Insulation Company, Houston, installed the Colorweld jacketing.

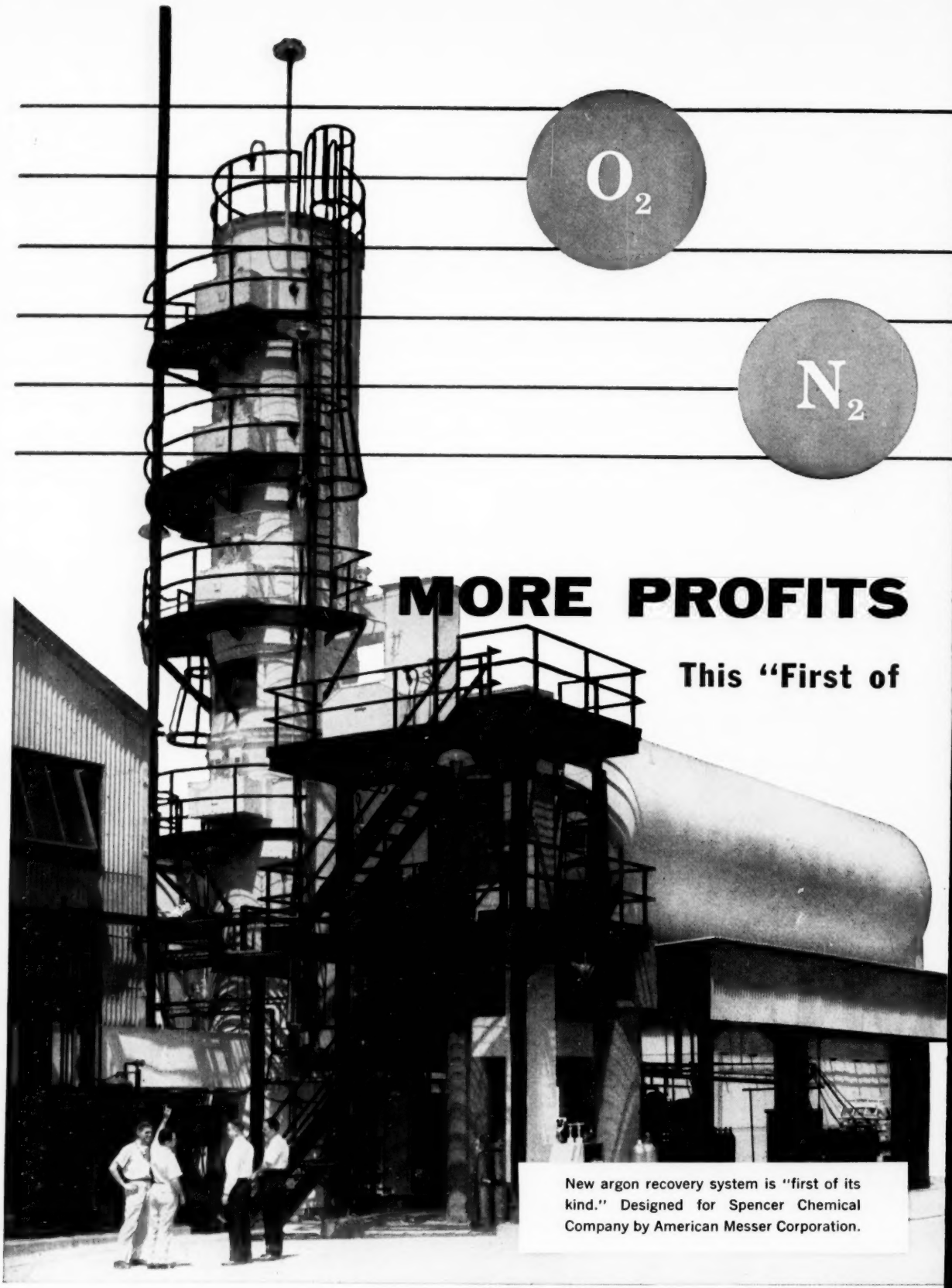
Colorweld jacketing adds eye-appeal to a processing plant, but it does even more: It will stay new-looking and clean with little or no attention. Its tough, baked enamel finish can be expected to outlast two or three ordinary paintings. Colorweld finishes won't fade or weather, and will resist scratching, peeling and chipping even throughout forming and fabrication.

The Lowry plant jacketing is .020″, .024″ and .025″ sheet, but Reynolds Colorweld Aluminum coils are available from .016″ to .051″, in widths from ½″ to 60″. It is offered in a wide range of colors, tempers and alloys.

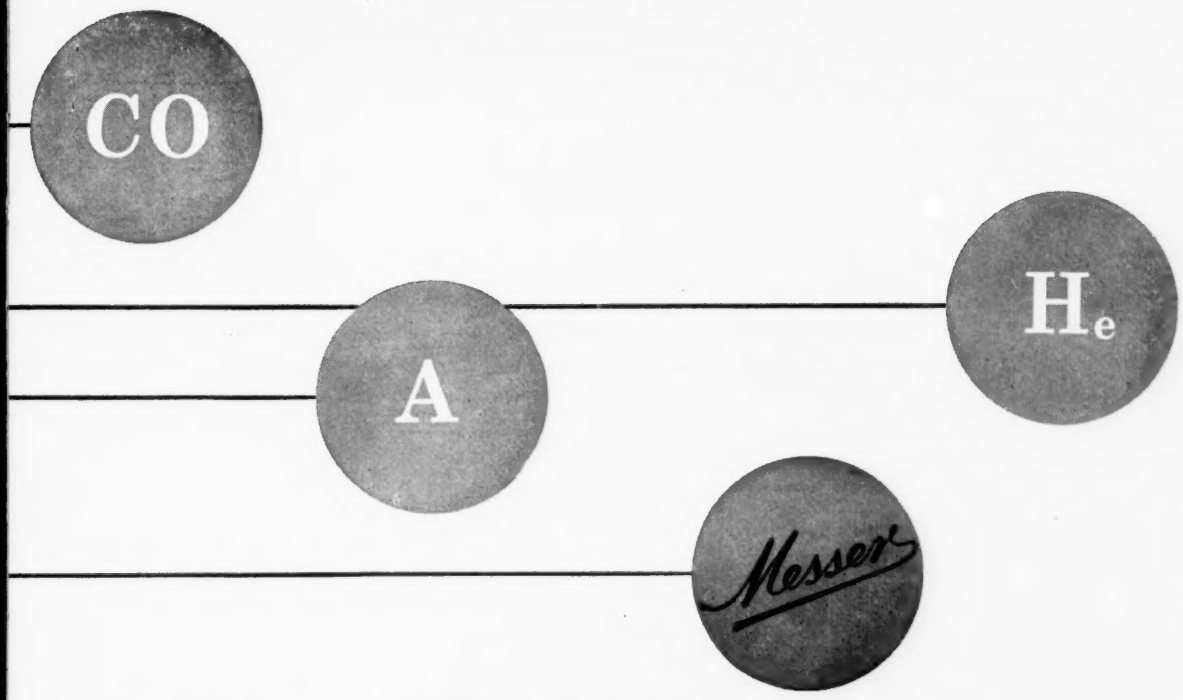
For the durability and low-maintenance protection of aluminum, plus the bonus of a tough, colorful enamel finish, investigate Reynolds Aluminum Colorweld coil, for jacketing and other applications. Contact your local Reynolds office, or write *Reynolds Metals Company, P.O. Box 2346-CJ, Richmond 18, Va.*

REYNOLDS ALUMINUM

Watch Reynolds TV shows—**"ALL STAR GOLF"** and **"ADVENTURES IN PARADISE"**—ABC-TV



New argon recovery system is "first of its kind." Designed for Spencer Chemical Company by American Messer Corporation.



IN AIR SEPARATION?

Its Kind" Plant May Give YOU Some New Ideas

How to make an air separation plant more profitable is illustrated by a recent accomplishment of Spencer Chemical Company. Through a new cryogenics system, Spencer now turns out substantial quantities of Argon from its Vicksburg, Miss. operation originally designed for making ammonia.

Spencer Selects American Messer

Spencer asked American Messer to investigate the possibilities of augmenting the ammonia plant's facilities to manufacture argon. Messer went to work. It undertook the design of a unique process to achieve the results Spencer was seeking.

What happened? Today this Vicksburg plant produces 3,000,000 cu. ft./mo. of ultra-pure argon from what was formerly a waste stream from the syn gas nitrogen scrubbing section of the ammonia operation.

This method permits much higher recovery of argon from the ammonia producing process than was previously possible by air separation techniques. Yet it in no way influences or upsets the balance of oxygen and nitrogen production important to the basic function of the plant-making ammonia.

Interested In Oxygen, Nitrogen, Argon, Helium?

American Messer is equipped and ready to consult with anyone whose manufacturing process could benefit from a more efficient and economical use of cryogenic processes. Be sure of the finest technical counsel! Your inquiry will be welcomed. American Messer Corporation, Chrysler Building, 405 Lexington Avenue, New York 17, N.Y.

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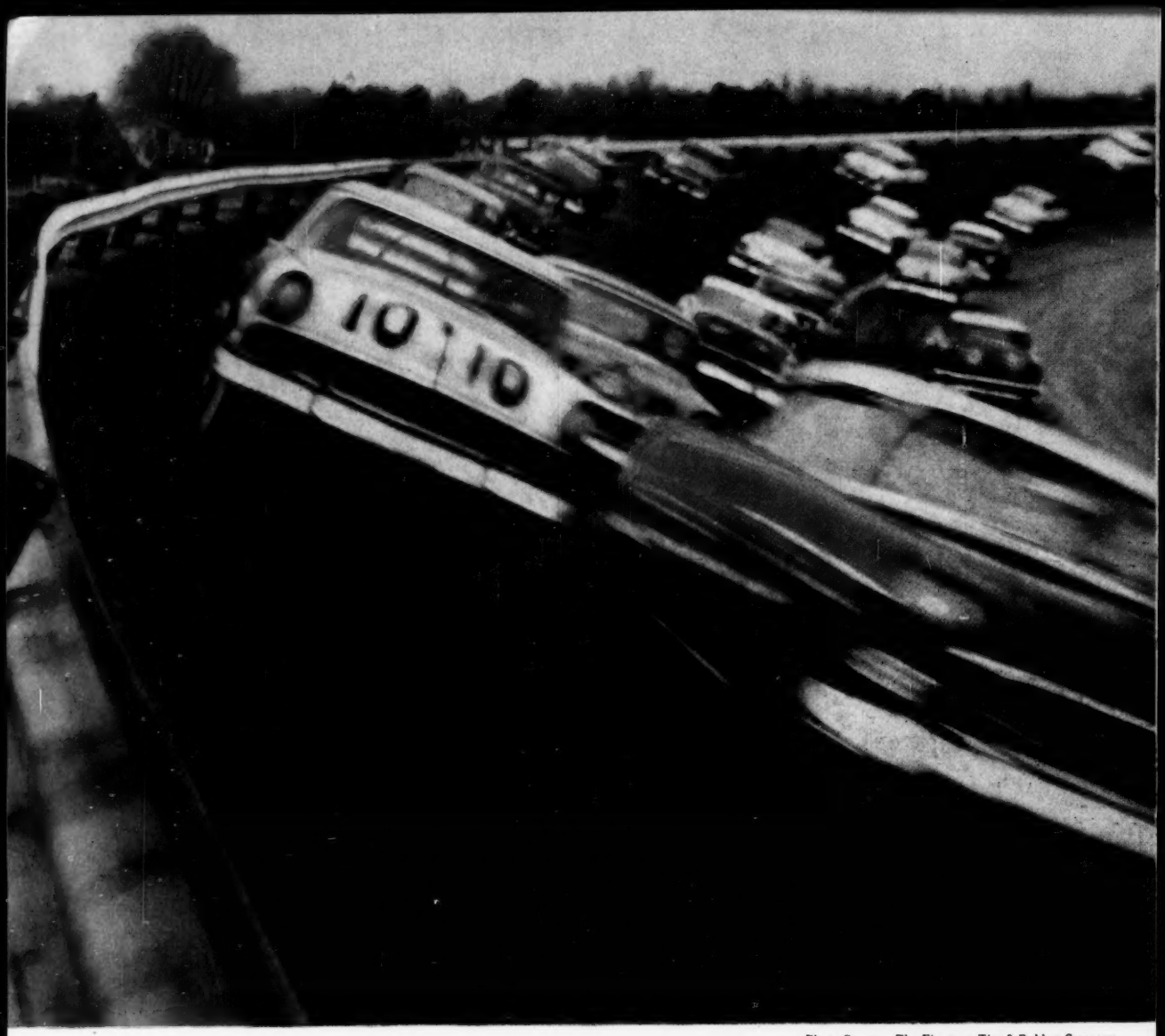


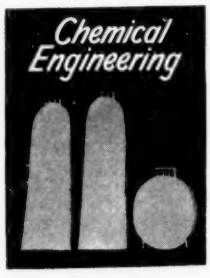
Photo Courtesy The Firestone Tire & Rubber Company

The Chemical Engineer drives 100,000,000 miles a day

Rubber and synthetic cord for tires, gasoline, hydraulic fluid... a few ways the Chemical Engineer and his technology keep America on wheels.

From rubber and gasoline to plastics and perfume, products of the chemical process industries affect every phase of modern living. Common techniques, equipment and raw material needs tie these industries into one super market place . . . buying $46-billion in raw materials and fuel, one third of all-manufacturing's capital goods. Throughout this industry complex, the Chemical Engineer is the man responsible for profitable operations—who instigates orders, specifies and buys.

To sell him wherever he is, come in the front door . . . via CHEMICAL ENGINEERING, the 3 to 1 favorite among chemical engineers in all functions, in all industry. Now they get it every-other-monday, read it more thoroughly than ever before. In 1958, Starch "Noted" scores were up 11.3%, "Read Most" scores up 28.7%, inquiries up 15.5% over 1957's monthly issues. CHEMICAL ENGINEERING, A McGraw-Hill Publication, 330 West 42nd St., New York 36.



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For safe, contamination-free handling of acids, essential oils, solvents, perfumes, various viscous materials, food concentrates and many other chemical preparations. Hackney drums are available also in Monel, Inconel and nickel. Features of Hackney protective alloy drums include:

- 100% smooth interiors—no place for germs, foreign matter to hide.
- High resistance to corrosion...protection against chemical changes.
- Metals that cannot impart flavor to contents of drum or discolor it.
- Seamless chime construction that makes bottom stronger and easier to keep clean.
- Availability of drums with and without rolling hoops.
- Choice of drums in 30- and 55-gallon capacities—with removable heads; with tight heads, 55 gallons.

For full specifications—in stainless, Monel, Inconel and nickel—write to the address below.

Insert shows detail of Hackney seamless chime construction

Pressed Steel Tank Company

Manufacturer of Hackney Products

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Branch offices in principal cities

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NEW

An exclusive *TRANTER advancement in heat transfer technology

MULTI-ZONE

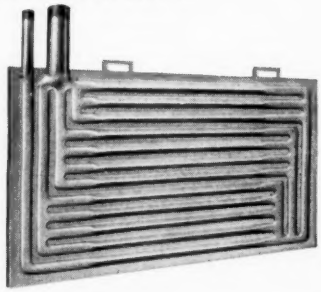
PLATECOIL®

DESIGN

*PATENTS APPLIED FOR

Years ahead performance plus all of the time-proven PLATECOIL advantages over pipe coils

The new MULTI-ZONE PLATECOIL features a multiple header configuration for improved steam distribution. The resulting increase in effective heat transfer area provides a built-in reserve capacity to deliver more heat during "start-up." It also speeds temporary recovery after introduction of work loads or processing ingredients for closer process control. Decreased condensate "trapping" produces FREE-FLO action.



OPERATING PRESSURES of 250 psi. now makes it possible to apply the cost-cutting advantages of PLATECOIL to a new range of heat transfer problems. DURAWELD construction with TRANSTEEL mill-controlled mild steel provides a safety factor of 4 to 1 at 250 pounds steam.

Replace pipe coils with the new MULTI-ZONE PLATECOIL and save on tank space, fabricating, installation and maintenance costs. Factory-fabricated PLATECOIL is available in a wide variety of sizes and styles including single embossed, double-embossed, banked and rolled units in TRANSTEEL, Stainless, Carpenter 20, Monel, Hastelloy C and Nickel.

WRITE FOR NEW BULLETIN P61
for complete specifications and data.

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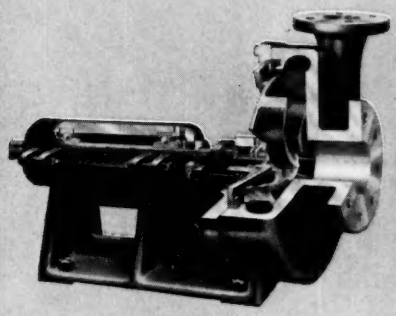
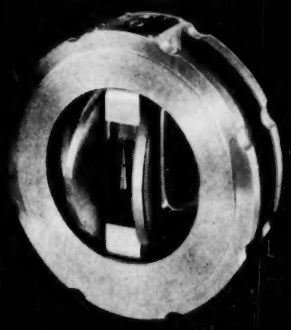
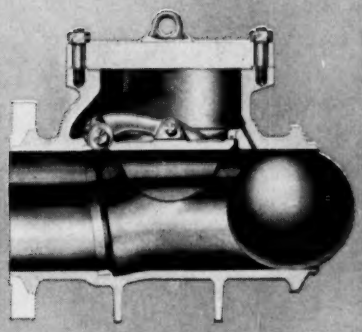


MISSION CENTRIFUGAL PUMPS are built to give long life, easy maintenance and trouble-free operation under all conditions. They feature a concentric casing that gives streamline flow at all flow rates and speeds. Mission Centrifugal Pumps are made in a variety of materials to resist abrasive or corrosive fluids.

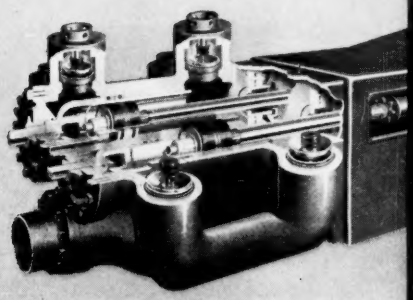


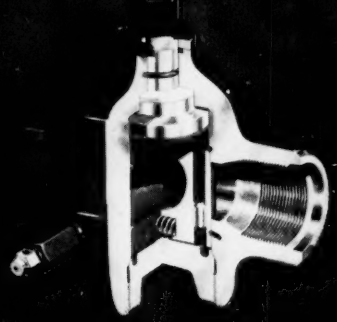


MISSION CONDUIT-CHEK VALVES are especially designed for product lines where spherical separators are used to prevent intermingling of different liquids. In its open position, the clapper is shaped to permit "conduit" flow. This design permits the easy passage of spherical separators, pigs, or scrapers.

YOU GET THE MOST FROM MISSION

MISSION RECIPROCATING PUMP PARTS. Mission makes a complete line of fluid end parts for double acting, piston-type reciprocating pumps. Three types of valves, three types of liners, two types of liner packing, two types of piston rods along with pistons and rod packing give a wide choice to satisfy most requirements. Parts made of special materials are also available on special order. Used in combination, Mission parts reduce pumping costs.





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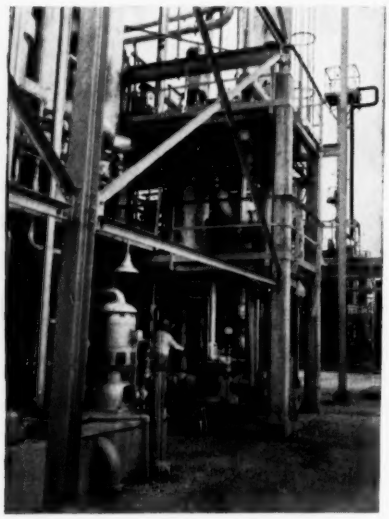
RODNEY HUNT

FLUID PROCESSING

RODNEY HUNT MACHINE CO., Process Equipment Division, 31 VALE STREET, ORANGE, MASS.



TURBA-FILM PROCESSOR EFFICIENTLY DISTILLS HEAT-SENSITIVE PRODUCT

This Rodney Hunt Turba-Film Processor performs a distillation process at a large chemical plant in the South where refinery gas is cracked into a number of basic petrochemicals that are subsequently processed into a wide variety of synthetic organics. The Turba-Film unit is used to recover a heat-sensitive product of low color.

TURBA-FILM PROCESSORS OFFER THESE COST-CUTTING ADVANTAGES

Simplified installation . . . compact design, readily accessible piping connections, and the new support brackets combine to make installation quick, easy and economical.

Less floor space . . . because of high capacity, continuous operation and low process hold-up, less floor space is required than with conventional equipment.

Quality control . . . since relatively small amounts of product are in process at any given moment, the condition of the product can be checked continuously and controlled instantly.

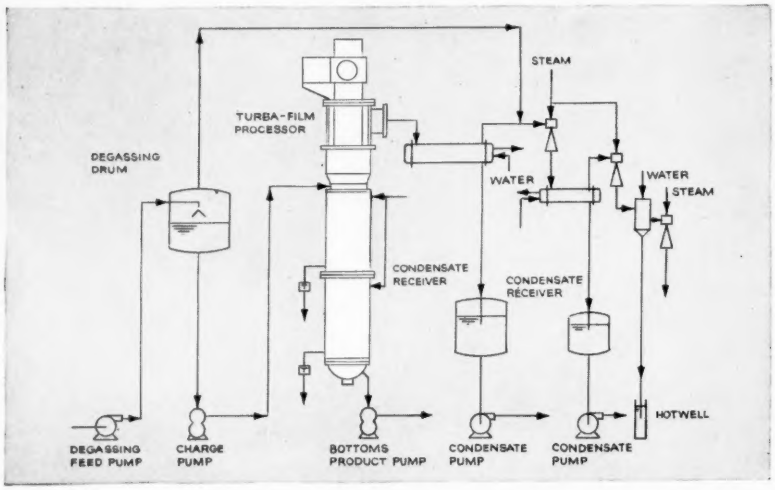
Minimized cleaning . . . Turba-Film units can operate for long periods of time without cleaning because formation of boundary layers, crusts, crystals and other deposits on heat-transfer surfaces is almost completely eliminated.

Flexibility of use . . . Low process hold-up permits quick and easy changeover from one product to another to provide for extremely broad flexibility of use.

For complete information about the Turba-Film Processor, write for Bulletin 117 or see pages 1465-1468 in the new 1960 *Chemical Engineering Catalog.*

RODNEY HUNT PROCESSORS THE KEY TO SUCCESSFUL PRODUCTION IN MANY APPLICATIONS

Rodney Hunt Turba-Film Processors and Vacu-Film Processors have proven to be extremely versatile not only in the range of industries and products they serve, but also in the different kinds of processes they perform. The units assure closely controlled uniformity of product in processes such as—concentration . . . deaeration . . . distillation . . . steam distillation . . . deodorization . . . liquisolids . . . desolventization . . . and homogenization. The flow chart below illustrates a typical CONCENTRATION process. Here a Turba-Film Processor successfully concentrates urea solutions from 80% to 99.5% by weight.



Other concentration processes frequently prove difficult and inadequate for a number of reasons: the extreme viscosity encountered in the higher concentration ranges; the short time-on-temperature demanded by heat-sensitive products; the build-up of cake resulting from products that stick to the walls of tube-type evaporators, etc. But with the mechanically aided, thin-film technique, these concentration problems are solved.

For example, one of the world's largest food processors uses the Turba-Film Processor for continuous concentration of gelatin liquor. The thin film of gelatin liquor that passes through the processor is kept in continuous motion over the heated surface. The material is never in contact with heat for more than a few seconds. Substantial economy is realized in the removal of water, resulting in lower utility consumption.

At another plant, a Rodney Hunt Turba-Film unit processes tomatoes to a concentration of about 3.5 to 1 at a rate of 3 tons per hour. In this as in other concentration processes utilizing Rodney Hunt processors, desired quality and character of the product in process is assured.

WE'LL SEE YOU AT BOOTH 1240 AT THE CHEM SHOW IN NEW YORK

As usual, the 27th Exposition of Chemical Industries at the New York Coliseum promises to be bigger and better than ever. We'll be there again in Booth 1240 from November 30 to December 4 and hope you'll drop in to see our exhibit. Both the Turba-Film Processor and the Vacu-Film Processor will be on hand for your examination, and Rodney Hunt process engineers will be in attendance to answer your questions about our equipment. In addition, we will introduce at the show a new Pre-Coat Filter that is applicable to all clarification processes and that will be of great interest to everyone in the process industries.

DEVELOPMENTS . . .

NOVEMBER 30, 1959

Chementator

T. PETER FORBATH

Port of Houston is charged by the Coast Guard with having insufficient fire-fighting equipment along Houston Ship Channel. More than 1,000 tons of foamite had to be rushed from distant points to the fire on Amoco's tanker Virginia at Hess Terminal this month, discloses Houston's fire chief.

Irradiation processing got a setback when Army suspended work on its $7.5-million Food Radiation Center at Stockton, Calif. Tests on animals have raised questions concerning potential dangers of irradiated food.

Preliminary estimates indicate chemical engineers continue to be a diminishing percentage of total engineering population. Whereas in 1958 8.3% of all engineering bachelor degrees granted were to ChE's, in 1959 ChE's are expected to take only 8%, in '60, 7.9%.

CPI's 1960 outlook bright

Chemical process industry is looking forward to the opening year of the coming decade with spirited optimism. Virtually every segment of the CPI foresees handsome increases in sales volume in 1960, is preparing for them with plans for marked boosts in capital spending in the year ahead.

This is the bright message revealed in the just-completed survey of Business' Plans for New Plants and Equipment conducted by McGraw-Hill's Dept. of Economics. A detailed analysis of the survey will be published in *Chemical Engineering*.

CPI's predicted sales increase over 1959 breaks down this way: 9% for chemicals; 6% for pulp and paper; 7% for nonferrous metals; 7% for stone, clay and glass; 7% for rubber; 8% for textiles; 3% for petroleum refining; 5% for food and beverages.

To equip itself for these sales boosts, here's how much each CPI segment expects to spend for new plants and equipment in 1960: Chemicals up 24% over '59 to $1.47 billion; pulp and paper up 35% over '59 to $828 million; nonferrous metals up 3% to $357 million; rubber up 31% to $233 million; stone, clay and glass up 11% to $603 million; textiles up 5% to $361 million; petroleum refining up 9% to $754 million. Food and beverages, however, plans to decrease its capital spending 1% below '59 in '60 to $783 million.

Myths about still-tray data scattered

A forthright attempt to sweep away the myths that linger around distillation-tray evaluations was made last month at AIChE's New York Section annual symposium. Revealing key findings of Shell Chemical's decade-long cost and performance studies in this murky area of technology, D. C. Hausch, company's chief of separation operations, sliced through the fog with striking and, to many, surprising conclusions:

NOW a single Condulet® for make motor starter and circuit breaker!

*TYPE DMC: Dust-Ignition-Proof (Dust-Tight) — National Electrical Code Class II, Groups E, F and G; NEMA Type 9EFG.

**TYPE WMC: Watertight — NEMA Types 3, 3R, 4 and 5.

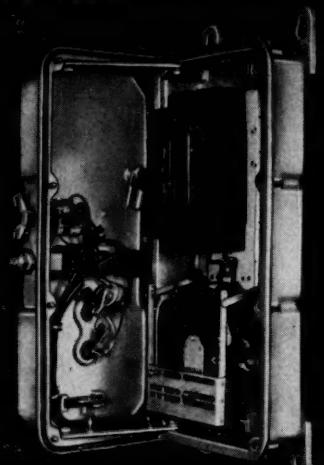
CROUSE-HINDS TYPES DMC* AND WMC** Combination Line Starter CONDULETS

DMC-WMC Condulets are designed to accept and operate any of the various makes of motor starters and circuit breakers. Single speed non-reversing combinations are equipped with a universal mounting plate, motor starter reset assembly and circuit breaker operating assembly. No substitutions of any parts on the Condulets are required.

Built-in push-button stations and selector switches with various contact arrangements, pilot lights and control transformers can be supplied. Push-button and selector-switch operating shaft holes and pilot-light holes may be drilled, tapped and plugged for future use.

Separate mounting lugs are bolted on body. A center position is provided on back of body so that lugs can be attached for 3 point suspension or center pole (2 point) mounting. Circuit breaker handle has provision for padlocking in "On" or "Off" position.

WRITE for descriptive literature and specifications . . . or contact your Crouse-Hinds distributor.



UNIQUE COVER HINGING ARRANGEMENT allows DMC-WMC Condulets to be mounted directly adjacent to other Condulets without providing extra space between for cover to hinge open. Cover pulls out, then to *either* side to clear adjacently-mounted Condulets or other equipment.

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● CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) ● FLOODLIGHTING
● TRAFFIC CONTROL SYSTEMS ● AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Atlanta Baton Rouge Birmingham Boston Buffalo Charlotte Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. St. Louis St. Paul Salt Lake City San Francisco Seattle Tulsa Washington
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• Of three basic tray types—bubble-cap, sieve and valve—you can't beat valve trays (at 70% of flood point) for general application.

• 24-in. tray spacing is best on all counts.

• Foaming systems fractionate easier, not harder, than nonfoaming systems because of greater transfer area—but you have to know foam characteristics.

• There's still a great need for good data on plate efficiency.

Commenting on the first point, Hausch declared that sieve trays are nearly as good as valves but design is more critical. Sieve efficiencies drop off sharply at their limiting capacities; valve drop-off is more gentle. As for bubble-cap trays, Hausch concedes there are some good designs.

Comparing four tray types at 24-in. optimum spacing and 70% of load capacity, Hausch gives these differential costs for separations (nonvariable costs excluded): valve tray, $126,000; sieve tray (10% area), $132,000; sieve tray (6% area), $134,000; bubble-cap tray, $167,000.

In reaching these conclusions, distillation system studied was held constant—85% recovery of 97% purity isopentane from a binary system. Separation required 50 theoretical trays; in commercial-size columns all trays had segmental downcomers.

New synthetics nab natural-rubber job

Synthetics' invasion of one of natural rubber's few remaining strongholds—foam—is turning into a thorough-going rout.

Goodyear last month unveiled a new styrene-butadiene latex as a 100% replacement for natural latex. Company flatly states that it's converting entirely to the new material, called Pliolite 5352, in the manufacture of foam cushioning. (Older S-B latexes have to be blended with around 65% natural latex, otherwise they're too thick and hard to process into foam.)

Too, Firestone and U. S. Rubber tell *CE* that they have been quietly marketing new styrene-butadiene materials for use in 100% synthetic latex formulations to compete with natural rubber, especially in foam applications. And B. F. Goodrich, with its freeze-agglomeration process (*Chem. Eng.*, Oct. 20, 1958, p. 59), has developed S-B latex materials that could take over natural rubber's foam jobs.

But new S-B latexes aren't the only synthetics bidding for natural foam markets. Urethane foam has succeeded in doubling its '58 sales to reach 75 million lb. in '59, and most of it's going into cushioning. So still another straw in the wind whispering natural rubber's near demise is the fact that Hewitt-Robins—a major foam processor—closed up its natural rubber foam plant in Buffalo, N. Y., this month, announced expansion of its urethane foam plant in Franklin, N. J.

Natural rubber's key assets have been that it can be easily molded into a variety of shapes, is more resilient and, because of its superior deflection-compression factor, it doesn't "bottom out" on prolonged use. In their new S-B latexes, the rubber companies believe they've captured these assets in a material priced 20-30% below natural latex.

Goodyear attributes the competitive characteristics of Pliolite 5352 to "optimum condition" of molecular weight of rubber particles and development of individual spheres of rubber to "selected sizes." About manufacture, company will say only that by means of a unique polymerization formulation, butadiene and styrene are brought together for short periods in continuous chain reactions.

Reprocessing data: AEC lure to industry

Atomic Energy Commission, trying hard to get private industry into the business of reprocessing spent nuclear fuels, has hit on a new lure. It's handing out for the first time solid economic and technical data on just what it takes to reprocess the various fuels now in use.

Last month some 250 top nuclear engineers from 75 companies received this kind of information at AEC's precedent-shattering "how-to" reprocessing symposium at Hanford, Wash. Guts of the meeting: remarkably detailed technical descriptions of AEC's four reprocessing plants at Hanford; Savannah River, S. C.; Idaho Falls, Idaho; and Oak Ridge, Tenn. (*Chemical Engineering* will publish a series of articles describing these plants.)

Most observers agree that this "technical" approach will prove superior to the "promotional" approach previously used by AEC in its efforts to jar private industry's reluctance about entering the fuel reprocessing field.

Firms need to know what they would have to invest and what return they could expect

(Continued on p. 22)

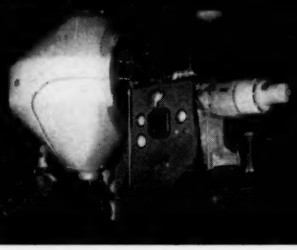
EXCLUSIVE SAVINGS *at Wallerstein Co.*

The Wallerstein Co. of Staten Island, N. Y., one of the nation's largest producers of enzyme chemicals, wanted to produce more sodium isoascorbate more efficiently. This heat sensitive chemical is used as an antioxidant for meat products.

A P-K Vacuum Tumble Dryer solved the problem by tripling output while materials handling time and

PRE-TESTED! Future savings in vacuum tumble drying can be previewed at P-K's Vacuum Tumble Dryer Pre-Test Laboratory. Pre-testing realistically points the way to economies in drying time, solvent recovery, process simplification and handling costs. It permits modification of controls, condenser, vapor line and other components to the individual needs of your process and product.

PRE-PACKAGED! Pre-packaging utilizes P-K's knowledge of companion equipment and parts. Units arrive completely assembled, fully balanced and ready for use. This eliminates costly, do-it-yourself trial and error during assembly and installation. It saves engineering time and overhead in every step from design through purchasing and start-up.



EXCLUSIVE COMBINATION!

Only P-K Vacuum Tumble Dryers offer pre-tested, pre-packaged savings. In pre-testing, results are predicted with a detailed procedure report and test samples. In pre-packaging, a single source of responsibility delivers a tailored, thoroughly proved assembly at a cost far less than a do-it-yourself project.

Compared to tray drying, the advantages of P-K Vacuum Tumble Dryers are overwhelming. Drying is many times faster. Expensive solvents are condensed and recovered. And caking that requires separate pulverizing and screening is eliminated. This greatly reduces handling and it safeguards against product contamination. It often saves enough in labor costs alone to justify investment.

Why not investigate the packaged P-K Vacuum Tumble Dryers more completely? We would also welcome an opportunity to conduct pre-tests of your materials in our Liquid-Solids Blenders*. Our pre-test facilities are at your disposal. Just call George Sweitzer, Stroudsburg (Code Area 717), Hamilton 1-7500, or write our East Stroudsburg Headquarters, 1511 Hanson Street.

* patented

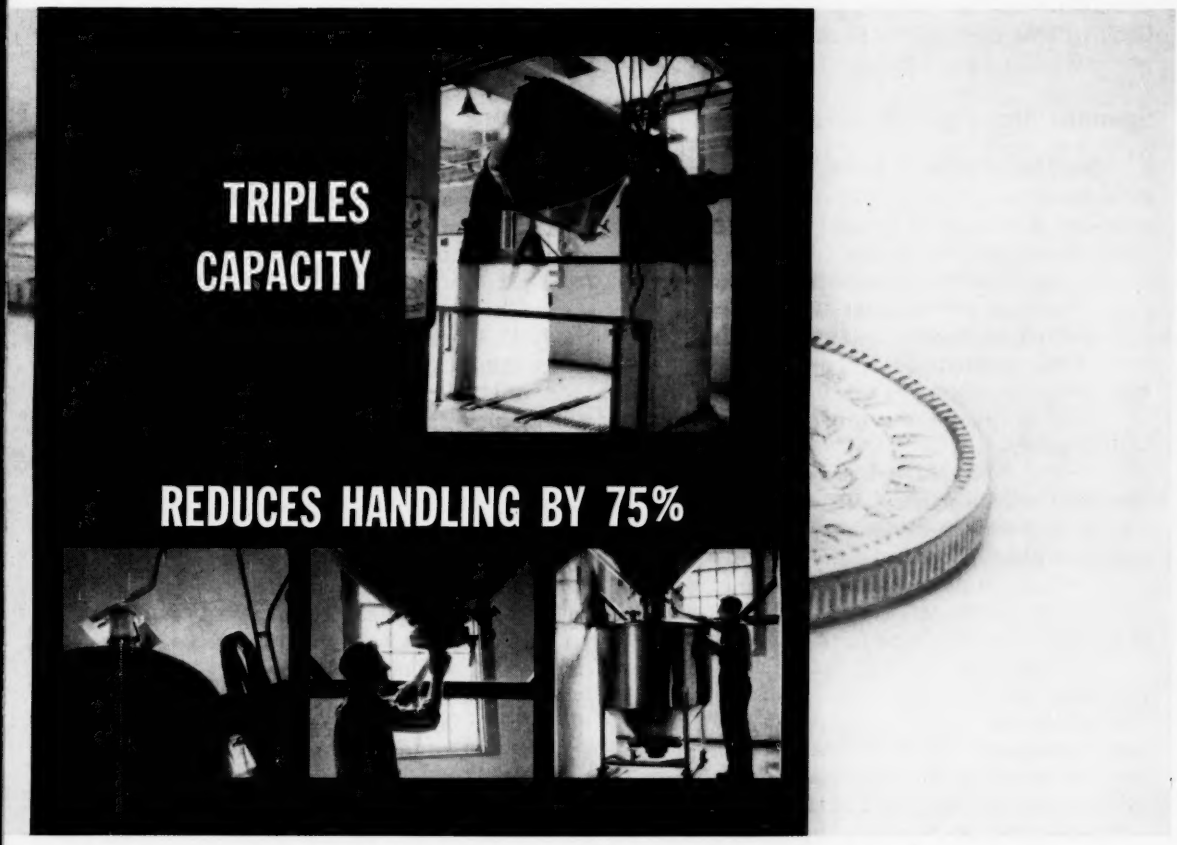
with P-K Vacuum Tumble Dryers

effort were cut 75% – a substantial cost reduction.

The P-K Dryer replaced a rotary barrel type unit, upping production from 800 lbs. per batch to 2,400 lbs.

Materials handling time and effort were reduced by taking advantage of the P-K dryer's convenient charging and discharging features. The unit is charged from the second floor through one apex of the double cone (see photos below). The dry powder is discharged directly into storage vessels rolled beneath the unit. The old rotary barrel dryer had to be discharged by hand shoveling.

Liquid content of the product is reduced under vacuum during drying. The condensed liquids are drawn off and reclaimed.



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predict your savings by pre-testing

Patterson Kelley

Chemical and Process Equipment Division

PATTERSON KELLEY CO., INC.
EAST STROUDSBURG, PENNSYLVANIA

Please send technical literature on P-K Pre-packaged Vacuum Tumble Dryers and details of your offer to pre-test our use of them.

Name_____ Title_____

Company_____

Street_____

City_____ State_____

from a reprocessing facility. Right now they feel the answer to the first is "too much" and to the second "too little."

A recent Argonne National Lab report points out that investment for a private firm in a typical 1-ton/day reprocessing plant would run about $30 million. To realize a 17% return on this investment—the minimum private industry is willing to accept—firm would have to charge $36,000/ton/day for reprocessing fuel. But AEC's current service charge is only $16,200/ton/day. Coupling this unfavorable economic situation with what they consider the painfully slow rate of growth of commercialized nuclear energy, private companies don't believe they can make money in the reprocessing business for some time to come.

Spandex fibers go commercial

Spandex, hitherto hardly more than a superfluous word in the Federal Trade Commission's dictionary of generic names for synthetic fibers, now stands for a bustling family of very real commercial materials. Within the past few weeks two Spandex-type materials—FTC-defined as synthetic elastic threads of at least 85% segmented urethane—set out to seek their fortunes in the competitive world of synthetic fibers. And others are expected to follow soon.

• Du Pont started construction on a "several" million dollar plant at Waynesboro, Va., to make much-rumored Fiber K, a polyurethane fiber now called Lycra.

• U. S. Rubber plans to put into commercial production at Gastonia, N. C., early next year a polyurethane fiber named Vyrene.

• Firestone tells *CE* that it has had a synthetic elastic thread under development "for some time," expects to make an announcement concerning commercialization within the next few months. Too, practically every other rubber company and every chemical firm with a stake in urethane is eyeing the Spandex field.

Spandex's attraction centers on its elastic properties. Notes Du Pont, "Lycra stretches and snaps back in place without distortion just like rubber." Moreover, it has two to three times as much restraining power as conventional elastic threads, is stronger and more durable, weighs a third less and wears longer. It can be machine washed and dried, is resistant to prespiration, cosmetic oils and lotions.

Because of these assets, Du Pont is aiming Lycra at the women's foundation-garment market and for use in sportswear. U. S. Rubber envisions Vyrene competing with its Lastex.

New BTX process for steelmen

Steel industry this month secures a potent new weapon for its running battle with the petroleum industry over the benzene-toluene-xylenes marketplace. It's a one-step catalytic process designed to do the dual job of purifying and dealkylating aromatic light oils—particularly coke-oven light oils—so turn out "chemical-purity" BTX.

Called LITOL, process was developed and is now offered for licensing by Houdry Process Corp. (Philadelphia) in conjunction with an unidentified major eastern steel firm. The latter is expected to be the process' first commercial user.

Coke-oven operators have been seeking far and wide for economic schemes by which to raise purity of their aromatic coal chemicals to the level of petroleum-base aromatics. For example, Jones & Laughlin snatched a page from petroleum's book, now uses a combination of Esso's Hydrofining and Universal Oil Product's Udex extraction at its Aliquippa, Pa. coal chemicals plant (*Chem. Eng.*, Jan. 12, 1958, p. 110).

Claims Houdry, LITOL offers virtue of simplicity over techniques such as this. Reason: It does both purification and separation job in a single stage, so eliminates need for costly second step involving solvent extraction or azeotropic distillation. Though close-mouthed about process details, Houdry says LITOL hydrogenates, desulfurizes, removes unwanted hydrocarbons and delivers a high-purity BTX stream. As a measure of how well it performs these jobs, company declares that benzene produced contains less than 1 ppm. thiophene, has freezing point above 5.4 C.

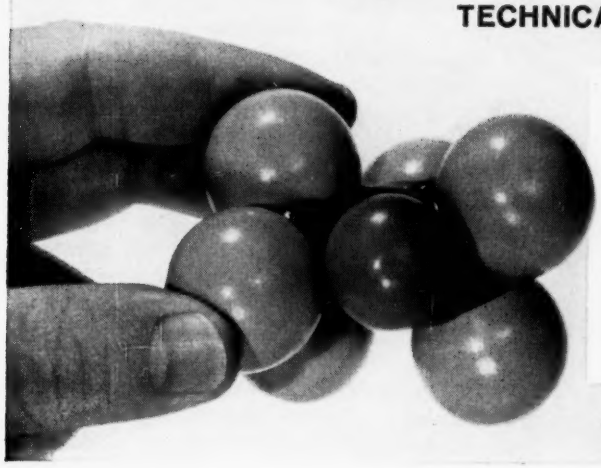
With dealkylation an integral part of the process, LITOL offers further advantage of converting much toluene and xylenes into more-valuable benzene. For this reason, Houdry expects that process will interest petroleum and chemical firms as well. Recently (*Chementator*, Oct. 19, p. 98), UOP introduced its Hydeal flowsheet for similar application.

Fiber use looms big for polypropylene

Fiber is fast becoming polypropylene's most promising marketplace. Technical problems of fiber manufacture, such as material's

HEXACHLOROACETONE $(CCl_3)_2CO$

TECHNICAL, 97%



Hexachloroacetone is a strongly ketonic, non-flammable chemical intermediate and solvent. Structure and properties of its derivatives suggest their application as pharmaceuticals, herbicides, fungicides and insecticides. Derivatives include alcohols, amides, acids, acid chlorides and chlorofluoro compounds such as chlorofluoro-acetic acids, -acetic anhydrides, -acetyl chlorides, -acetamides, -acetones, and -ketone complexes.

Which of these interesting reactions interests you?

Hexachloroacetone reacts very slowly with water to yield trichloroacetic acid and chloroform.

$$Cl_3C\cdot CO\cdot CCl_3 + H_2O \longrightarrow Cl_3CCOOH + CHCl_3$$

Hydrolyzes very rapidly with aqueous bases yielding sodium trichloroacetate and chloroform.

$$Cl_3C\cdot CO\cdot CCl_3 + NaOH \longrightarrow Cl_3C\cdot COONa + CHCl_3$$

Amines and ammonia yield amides of trichloroacetate and chloroform.

$$Cl_3C\cdot CO\cdot CCl_3 + NH_3 \longrightarrow Cl_3C\cdot CO\cdot NH_2 + CHCl_3$$

$$Cl_3C\cdot CO\cdot CCl_3 + (CH_3)_2NH \longrightarrow Cl_3C\cdot CO\cdot N(CH_3)_2 + CHCl_3$$

Hexachloroacetone reacted with aniline yields trichloroacetanilide and chloroform.

$$Cl_3C\cdot CO\cdot CCl_3 + C_6H_7N \longrightarrow Cl_3C\cdot CO\cdot NHC_6H_5 + CHCl_3$$

Heating of one molecular proportion of urea with two molecular proportions of hexachloroacetone, the amide is readily obtained.

$$OC\begin{matrix}NH_2\\NH_2\end{matrix} + 2Cl_3CCOCCl_3 \longrightarrow CO(NHCOCCl_3)_2 + 2CHCl_3$$

Reduction with lithium aluminum hydride produces hexachloroisopropyl alcohol.

$$Cl_3C\cdot CO\cdot CCl_3 + \xrightarrow[LiAlH_4]{2H} Cl_3CHOHCCl_3$$

Chlorinolysis of hexachloroacetone produces trichloroacetyl chloride and tetrachlorethylene or carbon tetrachloride and tetrachlorethylene.

$$Cl_3C\cdot CO\cdot CCl_3 + Cl_2 \longrightarrow Cl_3CCOCl + Cl_2C = CCl_2$$

$$Cl_3C\cdot CO\cdot CCl_3 + Cl_2 \longrightarrow CCl_4 + CO + Cl_2C = CCl_2$$

Reaction with hydrogen fluoride in presence of a catalyst yields chlorofluoroacetones.

$$Cl_3C\cdot CO\cdot CCl_3 + 4HF \longrightarrow CClF_2\cdot CO\cdot CClF_2 + 4HCl$$

Like to experiment with HCA? Write us on business letterhead for experimental quantity. Hexachloroacetone is commercially available in 5 and 55 gallon drums, and in tank cars. Mail coupon for Product Information Data Sheet.

Visit Allied Chemical Booths # 955, 957, 959 and 961 at the 27th Exposition of Chemical Industries in New York City, Nov. 30-Dec. 4

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CE-129

☐ Please send Product Information Data Sheet on Hexachloroacetone (DA-37501)
☐ Please send sample. Business letterhead is attached.

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City_____ Zone____ State_____

instability to extrusion heats or its difficulty to vat dye, are yielding to solution (*Chementator*, Oct. 19, p. 98). And resin manufacturers are either getting into the fiber-making business themselves or vigorously encouraging others to do so.

This month Industrial Rayon reveals that it has been working with Hercules Powder for over a year on a fiber development program, now plans semicommercial production of staple, tow and filament yarn at Covington, Va., by early 1960. To be called Prolene, products will include staple and tow in 2 to 15 denier/filament sizes, and yarns of 210 denier and greater.

To date, only Reeves Bros. (New York) has been making polypropylene fiber. But this month Montecatini started cranking up a 10-million-lb./yr. fiber plant in Milan, Italy. Firestone has stated that its planned polypropylene activity at Hopewell, Va., will include fiber production. And AviSun has fiber program under way with one of its parents, American Viscose. All the remaining U.S. firms in the polypropylene sweepstakes, Dow, Humble and Texas Eastman, are studying fiber making with more than passing interest.

Polypropylene fiber is lighter in weight, thus offers greater pound-for-pound coverage than most other synthetic fibers. It also exhibits high-tensile strength, low static electricity, great resistance to abrasion, acids and alkalis.

Tomorrow's Technology

Today's embryonic developments which have special significance for chemical engineers

Gas electricity for space craft?

While researchers have been exploring some pretty off-beat paths in their search for compact electrical power for space craft, General Electric this month has headed down perhaps the most off-beat of all. Tongue-trippingly named magnetrohydrodynamic power, it encompasses the century-old principle that electricity can be generated by passing hot ionized gas plasma through a magnetic field.

GE discloses that it has harnessed this principle in a lab-scale generator that produces 1,000 w. of electricity in 5-sec. bursts using an air plasma stream at 5,000 F. It feels that within the next two years it can come up with a magnetohydrodynamic generator to utilize the hot exhaust stream from solid-fuel rockets, so produce short bursts of sufficient voltage to send back to earth photographs of distant planets. And GE visualizes, though still several years away, continuously operating generators that supply all the electrical needs of space vehicles. In these, solar or nuclear energy would be heat source, gaseous conductor would be continuously recirculated.

Merits of this type generator: It has no moving parts, offers high energy conversion. Claims GE, unit can convert 40-50% of thermal energy to electrical energy compared with 35% efficiency for conventional turbogenerators. Problems still to be solved: Development of materials to handle high-temperature plasma, reduction of unit's weight.

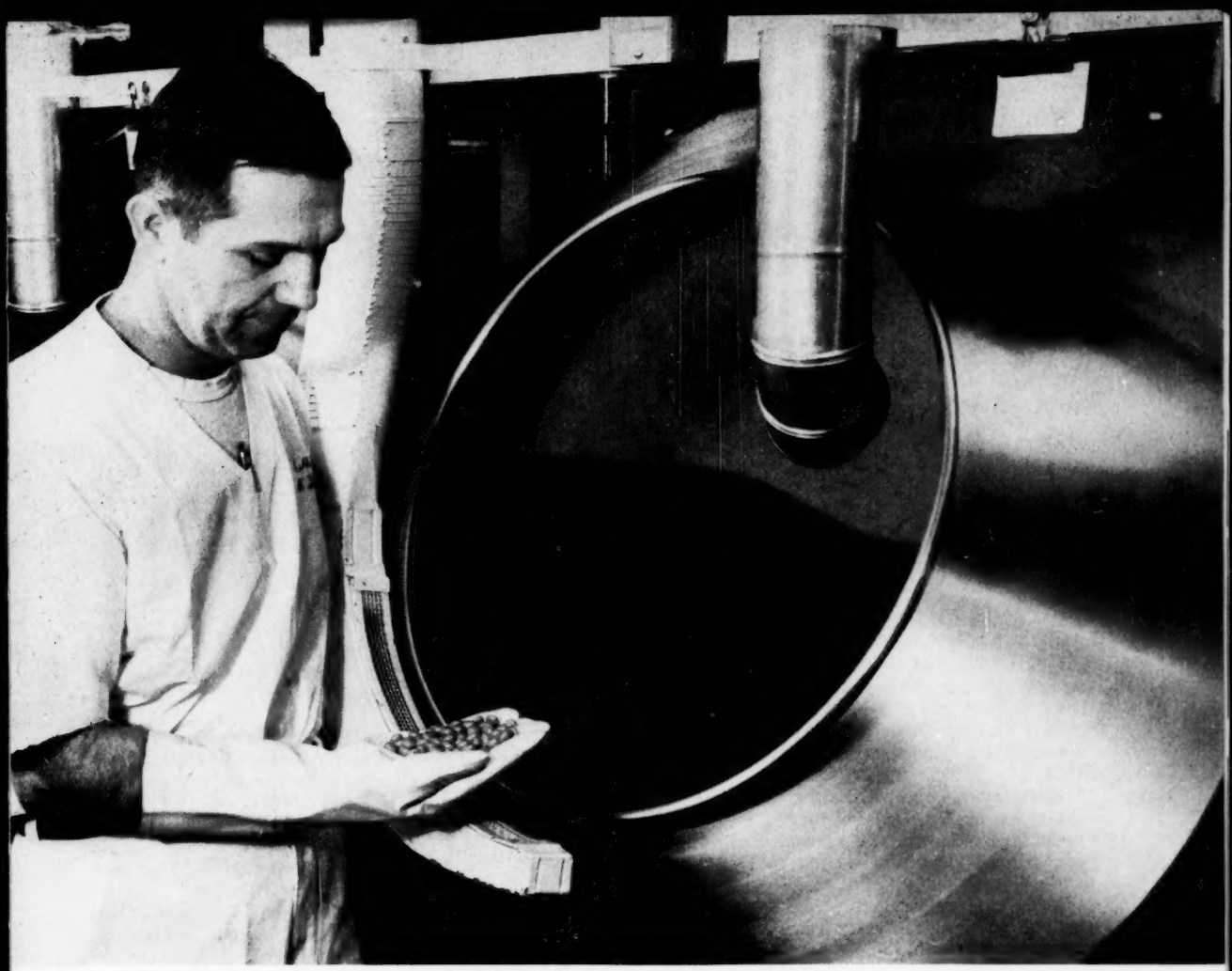
Research and development briefs

Yttrium-stainless alloys exhibit outstanding resistance to high-temperature oxidation, General Electric engineers find. Addition of 1% of the rare earth metal to 466 stainless boosts satisfactory oxidation resistance from 2,000 F. to 2,500 F. Too, it improves stainless' workability, weldability and resistance to recrystallization at elevated temperatures.

High-intensity-arc route to acetylene produces a high-temperature-resistant polymer as coproduct. Rumanian Academy of Science reports developing a process that involves passing methane through a high-frequency electrical discharge. Unidentified polymer made along with acetylene is said to resist temperatures up to 755 F., be insoluble in most solvents, have high electrical and acid resistance. Rumanians say process offers high yields of both products, would be economical to build and operate commercially.

Floating zone melting of boron is now possible thanks to new boron-preparation scheme invented by Bell Labs. Boric-acid-coated boron granules are pressed into forms, then heated under vacuum to 300-600 C. to decompose acid to boric oxide. Oxide coat on boron particles, on cooling, bonds powder into a strong bar suitable for zone refining, large crystal growth for semiconductor research.

For more on DEVELOPMENTS.....26



In this revolving drum, tablets are coated with syrups, powders and waxes. Because the drum is Stainless Steel, it takes only a few seconds to clean it with steam jets.

Stainless Steel equipment protects 100% product purity

at Eli Lilly and Company, Indianapolis, Indiana

"Science has created hundreds of lifesaving and pain-relieving formulas," says an official of Eli Lilly and Company. "But unless these formulas are produced in medicines that are 100% free of every possible contamination, they could do more harm than good. We make millions of tablets every month, for instance, and we must be positive that the ingredients are pure for every single one. That's why we use nothing but Stainless Steel for so much of our equipment.

"Stainless guarantees product purity. It resists corrosion. It's durable and hard, won't chip or crack. It has a smooth, dense surface that is easy to keep clean—and it is not harmed by the cleaning agents we must use. True, we paid more to install Stainless Steel, but it will save money in the long run because we don't have to worry about replacements."

Eliminate product contamination in your plant. Start by examining your equipment to see if it's a threat to cleanliness. Replace it with Stainless Steel. And specify USS Stainless Steel for service-tested quality.

USS Stainless Steel is available through your U. S. Steel representative or your local Steel Service Center.

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Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

USS United States Steel

DEVELOPMENTS . . .

PROCESSES & TECHNOLOGY

C. S. CRONAN

Fusion Power Question: An Answer in Two Years?

A Model C Stellarator may, in 1961, answer the question of whether controlled nuclear fusion can produce economical thermonuclear power.

Three scientists of Project Matterhorn, Princeton, N. J., reported this recently at a meeting of the American Institute of Electrical Engineers. The three are part of a staff now at work on a Model C at Project Matterhorn. They voiced hope that controlled nuclear fusion might actually be demonstrated by 1961.

Stellarator concept involves use of externally produced magnetic fields to confine a plasma of hydrogen ions and electrons while it is heated and maintained at temperatures high enough to produce fusion reactions.

Polypropylene Capacity Swells, No Limit Seen

There seems to be no limit to the enchantment that polypropylene can exercise on the market imaginations of many chemical firms. Take Montecatini for example. Last month its U.S. subsidiary, Novamont Corp., announced plans to more than double production capacity of its Neal, W. Va., plant. And it makes this move though on-stream target date for that plant is still well over a year away.

Last July Novamont declared that the Neal plant would make 11 million lb./yr. of polypropylene when it came on stream early in 1961. But now plant designs are being revised to up that figure to 25-million lb./yr. Reason: Rapidly burgeoning interest in polypropylene as compression molding and extrusion resins, as staple and filament for textiles, and as film for packaging. But, notes Novamont president Lucio Lucini, company's change in plans will not delay plant construction start, slated for this month, or on-stream date.

Novamont's move is the latest in the line of fast-breaking developments with the polyolefin. Hercules Powder has announced that it will expand its 20-million-lb./yr. plant to 50-million-lb./yr. Humble Oil is within a few months of bringing its 40-million-lb./yr. plant on stream. AviSun has already brought its 20-million-lb./yr. plant into operation. And Dow, Firestone and Texas Eastman, within scant months of each other, announced plans for polypropylene.

Process Air Cooling Is Getting Up Steam

As construction progresses on the world's first completely air-cooled refinery, Esso's at Whitegate, England, news of four more refineries, now in construction or design stage, points up a strong trend to more use of air in process cooling. Other refineries: Standard-Vacuum in the Philippines and in Turkey, Caltex in Spain, and Esso in Slagen, Norway. Whitegate air-cooler duty is 290 million Btu/hr., plant capacity 30-40,000 bbl./day.

Also, at Big Springs, Tex., Cosden Petroleum is putting on stream a light ends unit air-cooled by a 200,000-sq.-ft. air cooler built by Hudson Engineering. With a load of about 30 million Btu/hr., cooler handles light ends at low-level temperatures.

Design cooling-air temperature is 80 F., dry bulb. Inlet air is as high as 105 F. and is first cooled and humidified with plant waste water containing no acid, caustic or phenolic materials.

Air cooler is of cross-flow type with induced draft. Twenty fans of 10 hp. each provide the draft.

Cheaper Nuclear Power Via Fluid-Bed Reactor?

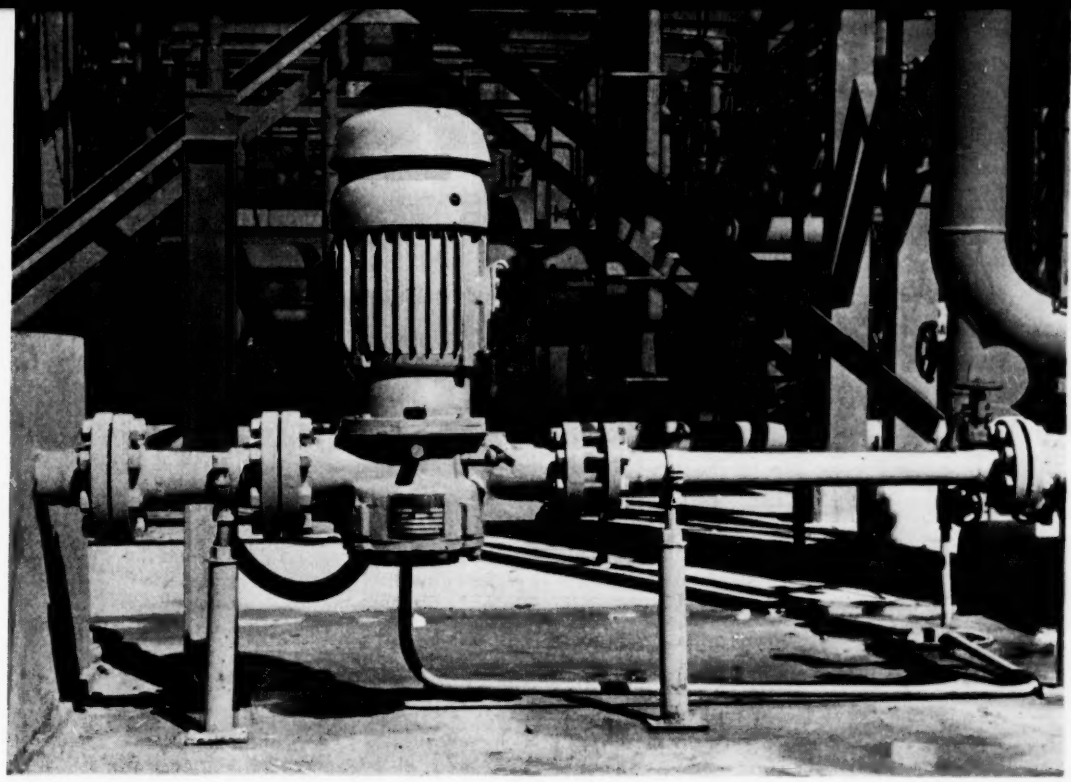
Pea-sized pellets of "slightly enriched" uranium suspended in a flow of water may be the key to simpler, cheaper nuclear reactor operation and economically competitive nuclear power in the future.

A liquid fluidized-bed reactor (LFBR) boasting such pluses will be built and operated by Martin Co.'s Nuclear Div., under terms of a 17-mo. contract recently signed with the Atomic Energy Commission. The new system, according to Martin, could lead to complete elimination of control rods and actuating equipment, and could cut fuel fabrication and reprocessing costs.

In the LFBR, reactor core will consist of an upright cylinder filled with fuel pellets immersed in liquid (water or organic fluids). Because a power-producing chain reaction takes place only when pellets are separated from each other by a precise, critical distance, reactor will be turned on simply by forcing liquid up through the bottom of the cylinder, causing pellets to rise and move apart.

Studies indicate that fissionable U-235 would be used up uniformly within all of the pellets, making for efficient refueling. Furthermore, since there's no structural material inside the core to absorb neutrons, conversion of U-238 into plutonium should be higher than in most types of reactors. Because of large area of contact between the thousands of pellets, heat transfer will be highly efficient.

Martin's $838,163 contract is AEC's first attempt to turn this concept into a workable core.



SHELL PUMP, with minor modifications, can take over about 520 different pumping jobs.

Shell Proves Out Standard Pump Concept

Independent of industry action, Shell Chemical proves that its own standard pump can cut initial, operating and maintenance costs, can replace 80% of plant pumps.

Although the September progress report from the American Standards Assn. B-73 Committee for pump standardization tells co-sponsors that final goals are in sight, at least one pump user has spurned delay, leaped into the arena and grabbed the bull by the horns. This week at the ASME Atlantic City meeting, Shell Chemical Corp. (Houston, Tex.) will tell how its own standard-pump program (*CE*, Dec. 15, 1958, p. 67) has already proved a whopping success.

In one, revolutionary pump design, Shell thinks it has found a replacement for 80% of the heterogeneous array of 650 centrifugal pumps currently in use at Houston. Plant tests with 16 of the new VRO (vertical, restricting-orifice) units for the past year show savings in installed costs of 20 to 35%. Pump maintenance cuts run from 15 to 25%.

All VRO pumps undergoing tests are of the same size—3 in. But each basic unit is fitted with an interchangeable venturi discharge orifice that permits the same 3-in. pump to substitute for any pump in the size range from ¾ to 3 in. Maximum design capacity is 390 gpm. at 135 ft. head; maximum differential head is 206 ft. at 125 gpm. NPSH varies from 4 ft. at 50 gpm. to 19 ft. at 390 gpm.

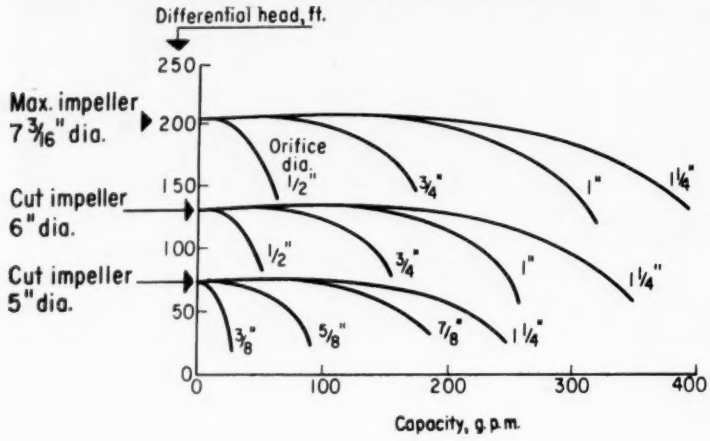
▶ **Worthy Objectives** — When Shell engineers started the program, one guiding light was their knowledge that the sum of maintenance and operational costs during the life of a chemical pump normally exceeds capital cost by several hundred per cent. Ultimately then, the standardized pump design had to emphasize reduction of continuing costs. Capital costs could not be disregarded, but maintenance cost-reduction features would be favored whenever a compromise became necessary.

Studies of maintenance procedures at the Houston plant showed that the pump should:

- Be quick to remove from service for shop repairs.
- Be simple to dismantle and reassemble in the shop.
- Have a minimum number of component parts.

In addition, all pump features

Impeller Size Influences Head-Capacity Performance



were expected to be consistent with basic standardization requirements of dimensional interchangeability and reliability.

From one head-capacity plot for all of the plant's existing centrifugal pumps, Shell established that the standard pump should be capable of developing a shutoff head of at least 200 ft., and a differential head of 120 ft. at a capacity of 250 gpm. A pump meeting these requirements would be able to substitute for about 80% of the plant's 650 centrifugal pumps.

▶**Pump Description**—Joint efforts of Shell and United Centrifugal Pumps (Oakland, Calif.) eventually led to the VRO—a pump that fulfilled all above-mentioned design objectives and specifications.

VRO is a vertical centrifugal pump with an integral electric drive. Close-coupled design helps to minimize the number of component parts. Major components are a case, cover, impeller, shaft, mechanical seal, sleeve and the venturi discharge orifice. All similar parts are dimensionally interchangeable between pumps.

Because the pump case is designed to withstand piping stresses, VRO installs quickly without a baseplate or foundation. Plug-type electric power and grounding connections for the drive motor also facilitate removal for subsequent shop repairs.

A common shaft serves both pump and motor. The impeller, impeller nut and the sleeve protect this shaft from process fluids. Such protection permits interchange of drives between alloy and carbon steel pumps.

▶**Orifice Alters Performance**—Use of interchangeable discharge orifices enables modification of pump performance.

As with other centrifugal pumps, efficiency of the VRO drops off at lower flow rates. Although low-rate efficiencies could be improved through appropriate selection of impeller patterns, Shell standardized on one pattern to minimize their spare-parts inventory.

Plot above shows the effect of orifice bore on head and capacity performance for each of three impeller diameters. All curves are for the same impeller pattern.

▶**Field Experience**—Shell put the prototype VRO into plant service in Jan. 1958. During the following 8 mo., 10 additional units went on stream in a wide cross-section of plant services. A few premature motor failures resulting from leaking corrosive vapors and liquids led to minor design modifications.

By Jan. 1959, 16 VRO's had gone into plant action. And in the first 6 mo. of 1959, Shell experienced only one minor failure, which was promptly remedied.

While it will be several years before Shell can fully evaluate the pump, indications are that it will permanently fill company needs for a versatile, standardized pump for chemical service.

New Process Now Treats High-Mercaptan Stocks

Big cost savings are claimed for a new, commercially tested process to caustic-treat a broad range of mercaptan-containing stocks, either by mercaptan removal or sweetening (conversion of mercaptans to disulfides which remain in the oil stock), or both.

Universal Oil Products, which developed the process, has tradenamed it Merox. A highly active, unidentified catalyst is used to promote a direct oxidation of mercaptans to disulfides with atmospheric oxygen at ambient temperatures. Catalyst can be dissolved in caustic soda, or, when higher activity is desired, it can be supported on a carrier and used in a fixed bed.

Cost of Merox sweetening of gasoline or No. 2 fuel oil is less than 1¢/bbl. In contrast, sweetening gasoline by conventional mercaptan extraction and copper sweetening costs nearly 8¢/bbl. Sweetening cost for No. 2 fuel oil by conventional hypochlorite process is about 2¢/bbl.

Treating jet fuels, says UOP, could be an important application of Merox. Process upgrades many sour stocks to commercial and military jet-fuel specifications.

In extraction, mercaptans are removed by caustic soda, forming a weak chemical combination with the caustic. Caustic is regenerated by blowing air through it, forming insoluble disulfides which can be removed in a gravity separator. In sweetening, where there's no change in sulfur content of the oil, air is introduced into a caustic-hydrocarbon mixture. Disulfides formed dissolve in the oil being treated.

Processes & Technology Continues on page 30.

*DEWATERING FIBROUS PULPS

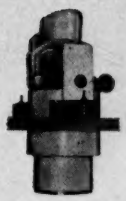
to residual moisture of 1% or less? . . . or medium-to-coarse crystalline solids? The Sharples Conical screen Continuous Dehydrator most likely is the type of Sharples centrifuge best suited for this requirement and there are four sizes from which to choose, covering a range of capacities from a few hundred pounds to 75 tons per hour.

for all types of solids deliquefication*

*NEED A RUBBER-LINED CENTRIFUGE?

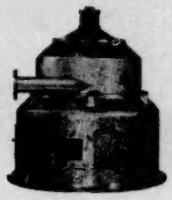
or other special lining? The Fletcher Division of The Sharples Corporation offers a complete range of sizes of both batch and automatic vertical basket centrifuges—in the usual selection of metals, plus rubber covering and other linings for special corrosive conditions.

*Continuous removal or classification of solid particles from suspensions (4 microns in size upwards).
Super-D-Canters

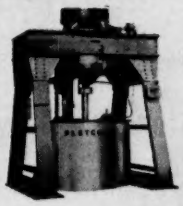


*Removal of solid particles from suspensions at pressures to 150 psi. (4 microns in size upwards).
Vertical Super-D-Canters

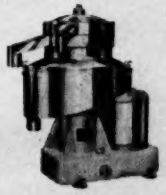
*Deliquefication and efficient multiple washing of discreet solid particles—at pressures to 150 psi.
Super-D-Hydrators



*Deliquefication of fibrous and medium-to-coarse crystalline solids.
Continous Dehydrators



*Broad range dewatering, recovery and washing of solids, liquid extraction and centrifugal filtering of liquids.
Fletcher Vertical Basket Centrifuges



*Concentration of finely divided or plastic solids.
Nozljectors

* *The term "Solids deliquefication" is recognition by Sharples of the growing number of processes in which non-aqueous mother liquor and/or rinse are required, and to which such time-honored designations as "dewatering" and "dehydration" do not apply. Collectively the five different types of Sharples centrifuges are all-inclusive in function, hence, "solids deliquefication."*

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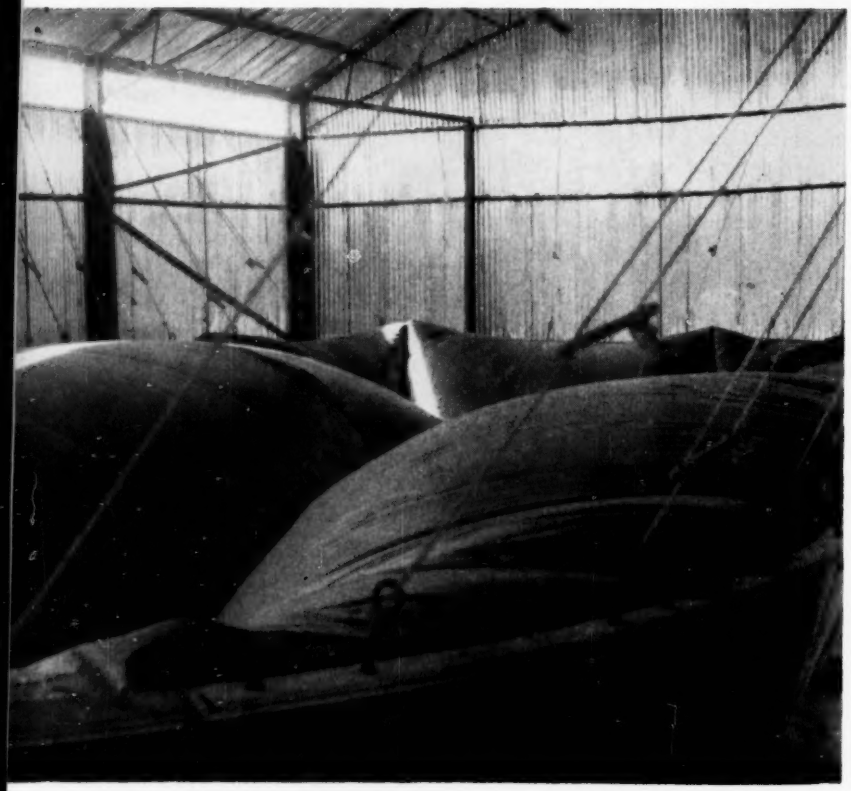


BREATHING CAPACITY of this vapor-collecting balloon, installed at Mobil's Kano, Nigeria, bulk plant in early 1959, is 20,000 cu. ft.

Balloons Return to Vapor Use

In the shifting economics of handling petroleum products, breather balloons have won renewed interest for trapping vapors.

Flurries of current engineering and marketing activity are brightening the future for a little-used method of vapor conservation. After 12 yr. of relative obscurity, breather balloons are getting more than cautious attention from several major gasoline producers.

Breather balloons, as their name implies, are inflatable containers for intermittent collection and safekeeping of vapors generated within storage vessels containing volatile liquids. Capacities vary from 500 to 35,000 cu.ft.

▶ **Acceptance Is Growing** — Until 1959, only Standard-Vacuum (overseas) and one U. S. midcontinent refiner saw enough merit in breather balloons to lay cash on the line. But early this year, Mobil International Oil Co. installed two of the big bags. One 20,000-cu.ft. unit went in at its Kano, Nigeria, bulk distribution facility. Another, 50,000 cu.ft. in size, was sent to Salonika, Greece.

As yet, Mobil has not gathered sufficient data to confirm payout predictions. However, engineering estimates set the time figure at 1 to 2 yr.

Even more recently, Texaco has ordered one of the balloons for use in Costa Rica. Whether stateside chemical makers and southern refineries will follow suit remains to be seen.

▶ **Advantages Cited** — Competition between breather balloons and the formidable array of other vapor-conservation devices will remain quite stiff. But the low-cost balloons often can win the contest for certain applications, says the manufacturer. In locales with hot climates, they are particularly economical for small and medium gasoline or solvent tanks having a small turnover. Required maintenance and repair are virtually nil.

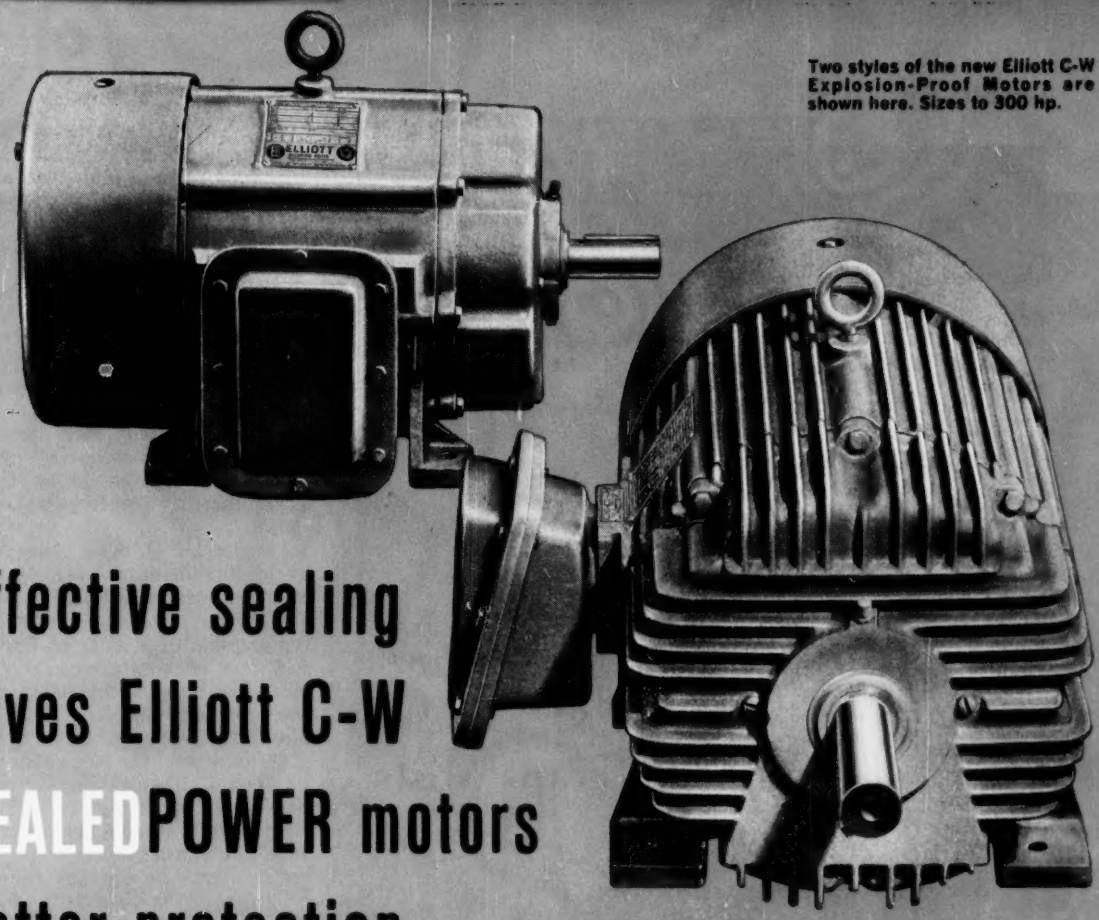
Another application is prevention of losses during transfer operations between distribution centers and tankcars or trucks. As liquids move from storage to the mobile tanks, or vice versa, vapors are pushed to the balloon rather than to the atmosphere. Likewise, no air can get into the distribution system.

One of the most important considerations to any prospective buyer is the product's transportability. Unlike floating-roof and steel-reinforced breathers, the balloons can be quickly collapsed, removed from the supporting footings, and transferred to an entirely different assignment.

▶ **Inexpensive Installation** — In typical installations, the breather balloons are located under shelter near the storage vessel. Supports hold the bag in an upright position away from the ground. Except for relief valves that function only in an emergency, the system is entirely closed.

Fabricator of the product is Air Cruiser Div. of the Garrett Corp., Belmar, N.J. Material of construction is neoprene-coated nylon fabric, manufactured by Reeves Bros., New York. When queried, Reeves confirmed that other resistant fabrics would be available if requested for special applications.

Processes & Technology Continues on page 32.



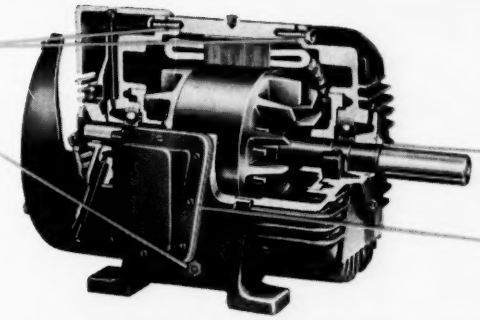
Two styles of the new Elliott C-W Explosion-Proof Motors are shown here. Sizes to 300 hp.

effective sealing gives Elliott C-W SEALEDPOWER motors better protection against moisture, dust, fumes, corrosion

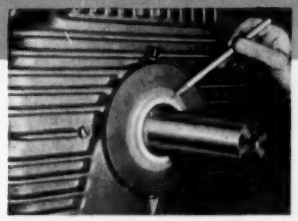
LONG, SNUG BRACKET SEAL. Close-fitting, deep rabbet provides explosion-proof type seal for all SEALEDPOWER motors.

EASILY ACCESSIBLE, automatic breather and drain plug, underwriters approved, for removing internal moisture accumulations.

NEW DATA on the complete line of Elliott C-W SEALEDPOWER motors is given in Elliott Bulletin PB 6000-2. Send for free copy today.

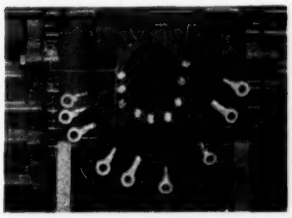


Elliott explosion-proof motor—underwriters approved.



ROTATING SLINGER PREVENTS entrance of dirt and moisture through the bearing and shaft opening.

NO LEAKAGE HERE. Tightly sealed leads and opening. Metal-to-metal fit between conduit box, frame and cover.



ELLIOTT Company

Crocker-Wheeler Plant Jeannette, Pa.

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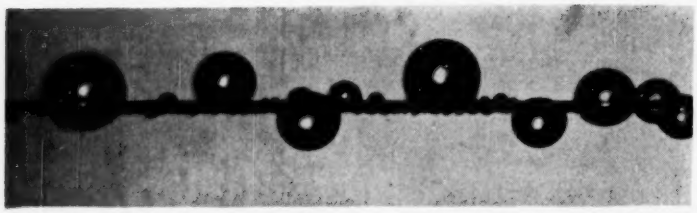
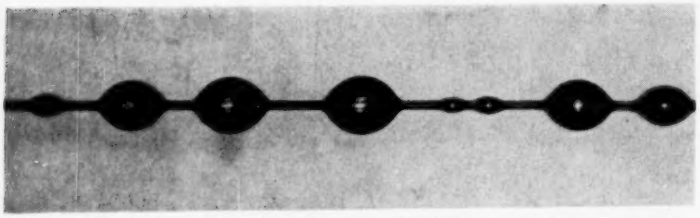


TREATED with silicone, glass fiber traps acid mist as discrete droplets.



UNTREATED glass fiber fails to trap all mist because drops wet fiber.

Fiber Phenomenon Traps Mists

Successful trapping of stack mists relies on fibers' ability to snare discrete droplets.

Recent reports from the other side of the Atlantic foretell of a new weapon for the process industries in their battle against stack-mist air pollution. This development—a new type of compacted-fiber mist eliminator—hinges on an interesting phenomenon revealed by Imperial Chemical Industries, Ltd., at Widnes, England.

Crux of the discovery is that mist droplets trapped on conventional fiber mats (e.g. glass wool, cotton wool, etc.) exhibit a tendency to merge, forming continuous bridged films. On the other hand, fine mists snared by certain synthetic fibers or silicone-treated glass fibers do not bridge. They form discreet droplets. (See photomicrographs above.)

In pilot-scale investigations of the nonbridging fibers, ICI and other U.K. firms obtained exceptional filtration results. Typically, efficiencies ran up to 100% for mists having particles 2 microns or smaller in size.

▶ **Wettability Not Key Factor**—At first, ICI researchers thought their studies indicated that the solution to the problem of making filters for fine mists was merely a matter of using "nonwettable" fibers. Further work, however, showed that this was not the case.

Nonwettable fibers extensively tested included silicone-treated glass wool, Terylene brand polyester, polyacrylonitrile, polyvinyl chloride, polyvinyl acetate, cellulose triacetate, nylon, slag wool and untreated glass wool.

Even though polyvinyl chloride is the least wettable fiber of this group, it did not prove efficient as a disentrainment medium. Terylene, one of the most wettable fibers in the list, turned out to be exceptionally good. On a par with Terylene was the silicone-treated glass; polyacrylonitrile fibers came in a close third.

Continuing these studies, ICI likewise found it impossible to relate efficiency with other measureable fiber properties, such as "moisture regain," etc. Over-all conclusion, revealed by microscopic examination, was that true criterion of ability to arrest fine mists lies in the fibers' tendency to trap particles as individual, nontouching droplets.

▶ **Mold, Then Heat-Treat**—Currently, the only fibers under consideration for general disentrainment application are Terylene and treated glass wool. Preformed hollow-center cylinders have proved to be the most practical filtration-element shape.

Fabrication of these elements by leading manufacturer, Mancuna Engineering Ltd. (Denton, Manchester, England) involves compression of a mass of fibers within a temperature-controlled mold. Heat treatment following the compaction step relieves fiber stresses.

Once formed, the elements can be housed either in single, rubber-lined steel casings or within large, multi-element chambers. Inlet and outlet duct arrangements depend on whether design calls for dry or irrigated (when gases contain soluble solids) operation.

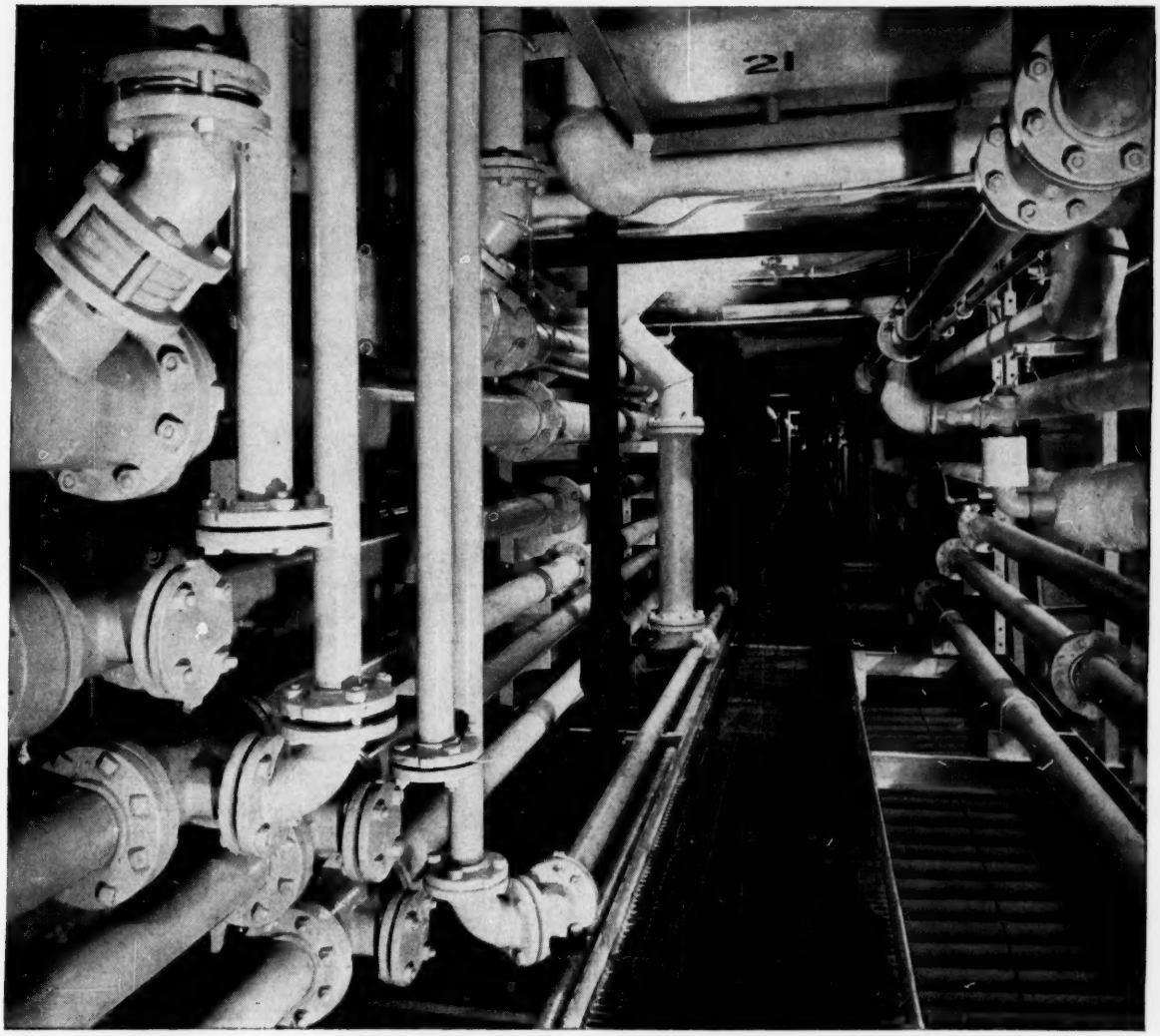
Capacities for various single-element units vary from 60 to 5,000 cfm.

▶ **Efficiency, Pressure Drop** — According to Mancuna's managing director, R. A. Le Page, "Investigation on pilot-plant scale [with feed gases containing about 3 mg./cu.ft. H_2SO_4] indicate that a non-irrigated unit will operate at efficiencies up to 100% on mists of 2 microns and finer, at a pressure drop of 10-11 in. H_2O. In the case of the irrigated form of the filter, pressure drop at maximum efficiency is likely to be on the order of 16½ in H_2O." Both of these resistances refer to Terylene elements packed to a density of 10 lb./cu.ft.

One unique feature possessed by Mancuna's products is that, at constant gas throughput, efficiency doesn't change with variations of the feed's mist loading. This relation holds for loading increases or decreases up to 400%.

Processes & Technology
Continues on page 34.

DOW | **SARAN LINED PIPE**



After six years of hot sulphuric acid . . .

Saran Lined Pipe still performs dependably

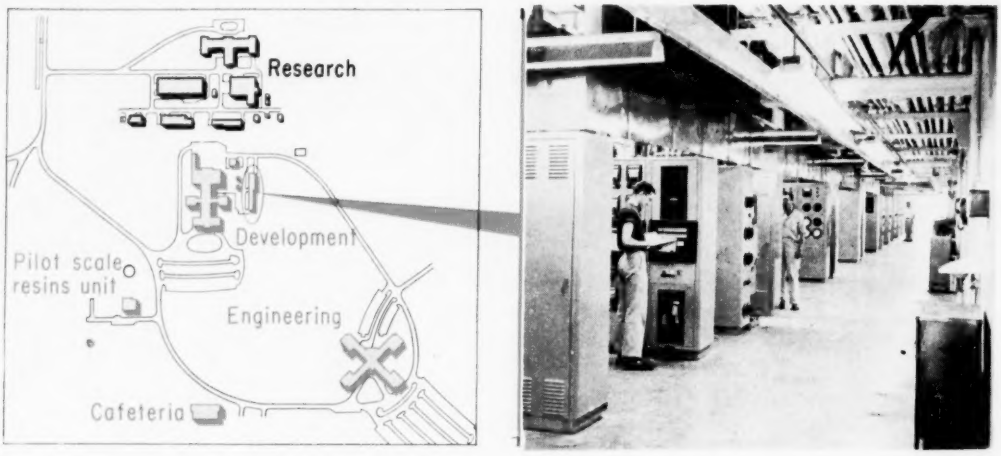
When 20,000 linear feet of pipe must carry a constant stream of hot sulphuric acid . . . when production requirements make pipeline failure intolerable . . . pipeline dependability is the lifeline of the plant. For the past six years, Saran Lined Pipe has carried dependably an unending flow of corrosive chemicals at Industrial Rayon Corporation's Painesville, Ohio, plant.

The installation shown above carries hot sulphuric acid and other chemicals used in Industrial Rayon's Continuous Process method of making tire cord. This Saran lined supply and return piping, serving all of the plant's spinning machines, carries the solutions from lower levels to spinning machines on the main floor. Pumping pressures range from 45 psi upward, and solution temperatures are above 125° F.

The Saran Lined Pipe was installed in 1953 and has been in continuous use since. Maintenance costs have been extremely low and I.R.C. engineers report that, during these six years, Saran Lined Pipe has performed dependably under their corrosive operating conditions.

Whenever dependable piping systems are required, whatever the degree of corrosion or chemical activity, consider Saran Lined Pipe. Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200° F. They can easily be cut, fitted and modified in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Dept. 2282AK11-30.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN



Technical Center Forms Around Research Nucleus

At South Charleston, W. Va., Union Carbide Chemicals Co. now boasts a Technical Center which brings development and engineering groups into new facilities adjacent to the 10-yr. old research installation. Totaling 12 buildings that house more than 2,200 people, the center includes major structures for research, development and engineering; two high-pressure laboratories; one chemical and two plastics-resins pilot plants; application research laboratory; radiation laboratory; cafeteria and supporting facilities. Photo above shows the control area of the Development Dept.'s 21-cell high-pressure laboratory which is behind reinforced concrete wall.

Superpure-Aluminum Maker Getting Bigger

U.S.'s third and by far largest producer of superpurity aluminum is planning a major expansion after barely a year in the business.

Aluminum Foils, Inc., American subsidiary of Swiss firm Aluminum Industrie A.G. who pioneered manufacture of this material, has a program on the drawing boards to step up the 100,000-lb./mo. output of its Jackson, Tenn., plant to 260,000 lb./mo. To accomplish this, company tells *CE*, it will add 16 modified-Hoopes three-layer refining cells to the 10 units now on the line.

AF's move closely follows Kaiser's recent announcement that it had tripled capacity of its Mead, Wash., superpure-Al plant to 75,000 lb./mo. with installation of two new cells (*Chementator*, June 29, p. 42). Reynolds is the only other known domestic producer of the material. It put six refining cells on stream at Listerhill, Ala., last year.

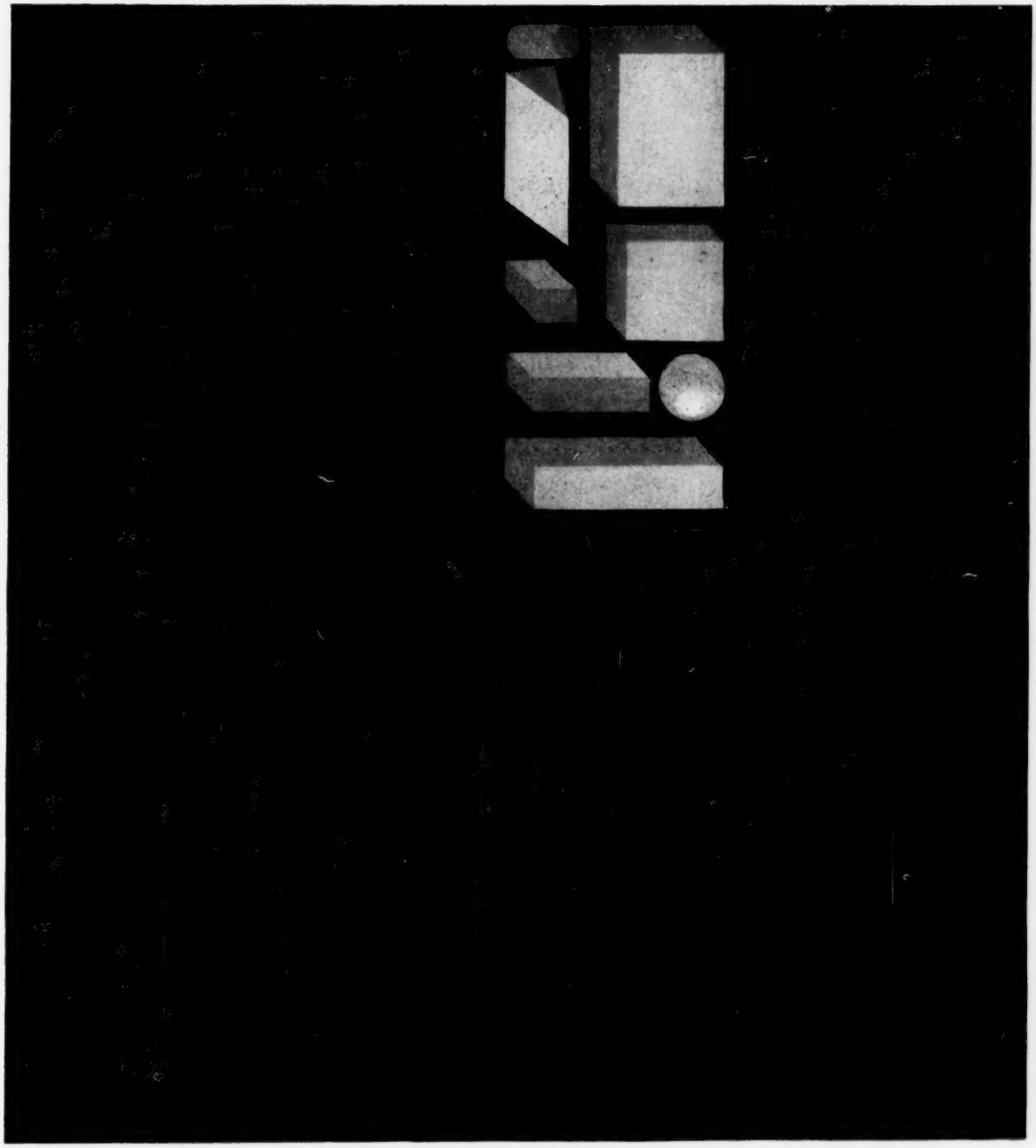
Surge of activity stems from growing markets for ultra-high-purity aluminum in catalysts, electrical capacitor foil, auto trim and jewelry. An additional factor prompting AF's expansion: Alcoa, long an importer of the material, is now turning to the Swiss subsidiary.

AF offers 99.992% purity aluminum but says that it's equipped to turn out metal of 99.9999% grade. Reynolds and Kaiser both sell 99.99% metal.

NEWS BRIEFS

Bisphenol-A: Monsanto and Union Carbide have each announced plans to build new plants for bisphenol-A, an intermediate in making epoxy, polycarbonate and oil-soluble phenolic resins. Union Carbide Plastic Co. will have a 25-million-lb./yr. plant on stream at Marietta, Ohio, in 1961. Monsanto has started a 50% expansion at its St. Louis, Mo., plant.

Synthetic rubber: Australia, Brazil and India are moving ahead on individual plans for styrene-butadiene rubber plants. Fluor International, S. A., is constructing Australia's 33,000-ton/yr. plant at Altona near Melbourne and will have it on stream in 1961. Brazil will have a 40,000-ton/yr. plant near Rio de Janiero, will use alcohol distilled from sugar as a raw material. India plans its 20,000-ton/yr. plant for Bareilly (Uttar Pradesh state), will also use alcohol from sugar.



Don't let rising process heats ruin your refractories

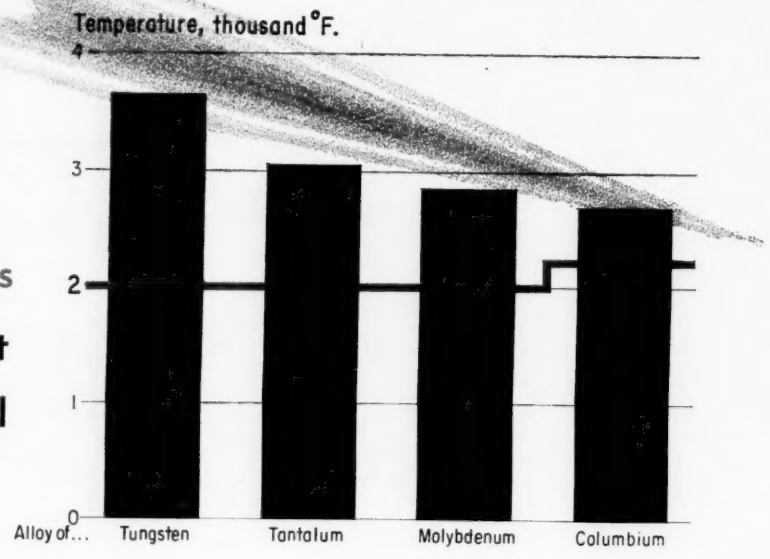
...or your profits... *mix imagination with Alcoa Aluminas*

The steady increase in general process temperatures poses no problem at all for refractories fortified with ALCOA® Aluminas. Their refractoriness rises in direct proportion to the amount of alumina in their composition. These high-purity aluminum oxides also add greatly to strength and stability under load at elevated temperatures. And high-alumina refractories are chemically stable, immune to both oxidizing and reducing atmospheres. They offer just one more illustration of the many good reasons why makers and users of a variety of products have found it pays to *mix imagination and engineering with Alcoa Aluminas . . . to make an old product better or a new product possible.* Discover what ALCOA Aluminas can do for your own product or process. Outline your requirements in a letter to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 706-L Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA CHEMICALS

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV

For finer products . . . let Alcoa add new dimension to your creative thinking!



Useful limits fall far short of alloy potential

Wanted: Better Refractory Alloys

2,000 F. is about as far as engineers can go with today's alloys. Space-age metallurgy will help them hurdle this thermal barrier.

Roland A. Labine, Assistant Editor

"Look, George," says the design engineer to his metallurgist friend, "I need an alloy I can use at 3,000 F. at high stress in an oxidizing atmosphere."

"Sorry, Harry," the metallurgist replies, "we haven't developed anything that good yet. But you'll have it in a couple of years, I can certainly promise you that."

This apocryphal conversation sums up pretty well the status of the "exotic" or "space-age" refractory metals: Our present metals and alloys cannot match up to the ambitious plans that the designers have in mind.

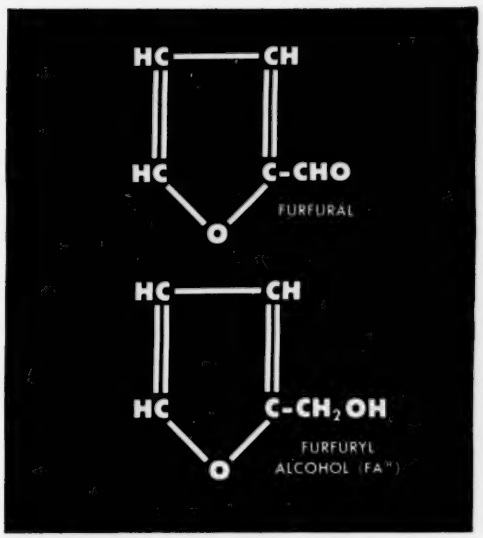
But metals research being carried on for the atomic power and missile programs is bringing about some dramatic changes in materials heretofore thought unmanageable. And in two to five years many of these developments will be available to the chemical engineer who currently faces an 1,800-1,900 F. temperature barrier imposed on even our best nickel-cobalt alloys. Some of the new columbium and tantalum-based alloys will raise this limit by several hundred degrees when they become truly commercial.

Five high-temperature metals now dominate the "exotic" metal scene: beryllium, columbium (niobium), molybdenum, tantalum and tungsten. Beryllium, not a refractory metal like the other four, is in a class by itself and seems a sure bet to find a big place in atomic and missile applications.

Of the remaining four, columbium is in for the biggest growth over the next three to five years;

Benefits of QO Chemicals

AS REACTIVE SOLVENTS, QO® FURFURAL AND QO FURFURYL ALCOHOL PUT ABRASIVES IN A "BIND"



QO Furfural and QO furfuryl alcohol are used as solvents and wettants of phenolic resin binders by many manufacturers of grinding wheels, brake linings and other friction elements. One of the big benefits from the use of furfural and furfuryl alcohol is that they do not volatilize but remain as part of the final bond. Here are the results of our laboratory tests on this question:

Furfural and FA readily dissolve the phenolic resins. Reactivity is shown by tests in which we added (a) ten parts and (b) twenty parts of furfural and furfuryl alcohol to one hundred parts of resin, triturated the system to thoroughly distribute the solvent in the resin, then baked an aliquot of each system in a shallow pan at 80°C. for 3¾ hours, 100°C. for 24 hours, and 180°C. for 24 hours. Precaution was taken to make sure that the samples did not contain free furfural or furfuryl alcohol after the baking cycle. The samples were weighed before and after baking, and compared with control samples of the resin containing no furfural or furfuryl alcohol.

REACTION OF FURFURAL AND FA WITH PHENOLIC RESINS

Resin*	Percentage Added		Percentage Furfural or Furfuryl Alcohol Retained
	Furfural	Furfuryl Alcohol	
Resin #1	10		90
Resin #2	20		87
Resin #3		10	94
Resin #4		20	86
Resin #5	20		85
Resin #6		20	83
Resin #7	20		88
Resin #8		20	85
Resin #9		20	77
Resin #10		20	87
Resin #11	20		88
Resin #12	20		87
Resin #13		20	84
Resin #14 (sirup)	20		69
Resin #15 (sirup)		20	80

*Resins identified upon request.

It is evident that a high percentage of these solvents reacts with and remains a part of the final resin bond. This suggests that if you are in a "bind" on a problem requiring a reactive solvent, you ought to consider QO furfural or QO furfuryl alcohol.

For more complete information, write for Bulletin 126.

The Quaker Oats Company
CHEMICALS DIVISION

The Quaker Oats Company
CHEMICALS DIVISION
QO CHEMICALS

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Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France;
A/S "Ota", Copenhagen, S. Denmark
In Australia:
Swift & Company, Ltd., Sydney
In Japan:
F. Kanematsu & Company, Ltd., Tokyo

Facts About Five High-Temperature Metals

	Beryllium	Columbium	Molybdenum	Tantalum	Tungsten
Metal Price ($/lb.)	45	55	3.50	60	3.50
Cost of Mill Products ($/lb., approx.)	200	60	60	65	100
Metal Price Outlook ($/lb., next 2–3 yr.)	35	30*	Little change	35	Little change
Metal Production (1958, thousand lb.)	120	28	2,499 †	400–500	3,600 †
Consumption Outlook (Thousand lb./yr.)	1,000 (less than five yr.)	150 (by 1961)	Modest growth	Modest growth	Modest growth (next few years)
Melting Point (°F.)	2,340	4,380	4,760	5,425	6,170
Advantages	High strength-weight ratio	Easily fabricated	Plentiful; advanced technology	Corrosion resistance; easily fabricated	Highest melting point
Drawbacks	Hard to fabricate; toxic	Oxidizes slowly at high temperature	Rapid oxidation	High density; limited reserves	High density; fabrication problems

* At higher production rates; † Most consumed at present for other than high-temperature uses.

CE has learned that a report, compiled by well-informed industry observers and recently submitted to the Materials Advisory Board, concludes that columbium has the best combination of properties and is most promising for full-scale government development.

Over the next decade, tungsten with its tantalizingly high melting point (6,170 F.) will be much more widely used as a material of construction—but not before a lot of tough problems are solved.

▶ **Beryllium's Bullish**—Beryllium is still in its infancy as a material of construction, but with the present accent on rockets and missiles its future looks bright. Right now beryllium has plenty of drawbacks (brittleness, toxicity, lack of high-grade U. S. deposits) but there are several-million-dollars' worth of contracts out right now which should do a lot towards mitigating these faults. But beryllium's high price (around $300/lb. for some shapes) will keep it limited primarily to missile and atomic applications for quite a while.

The two U. S. producers—Beryllium Corp. and Brush Beryllium—will produce around 300,000 lb./yr. between them in 1959. The AEC is currently buying 37,500 lb./yr. from each with the balance going to private atomic power projects, missile and space programs, and the Air Force. Beryllium's low neutron-absorption cross section, coupled with its ability to moderate and reflect neutrons, seems to cinch its place in atomic energy, especially where neutron economy is a factor.

As a material of construction, beryllium is currently being used for components of inertial guidance systems that must keep their close tolerances under heavy stress. And because of a high strength-to-weight ratio and ability to withstand 1,200 F. temperatures (which might be extended to 1,500 F. with alloying) beryllium is a strong contender for air-frame construction — once some formidable fabrication problems are licked.

▶ **Fabrication Problems** — Recent entry into beryllium fabrication by such concerns as Wyman-Gordon makes forging of larger parts possible, but this is no cure-all for beryllium's fabricating woes. The Air Force currently has four major development contracts out on beryllium: (1) Casting program being carried on by Beryllium Corp. to try to eliminate the need for powder-metallurgy fabricating processes. Company reports "some strides," but says it is still too early to determine if forging billets can be cast directly from vacuum-melted metal. (2) Sheet rolling program being carried on by Brush Beryllium, using powdered-metal billets, is aimed at getting uniform, ductile sheet. Firm says it is rolling beryllium down to foil thickness and has sheet and plate commercially available in sizes 20 in. wide by 40 in. long and in gages of 0.020-0.375 in. (3) Forging contract with Ladish Co. is attempting to find better ways to form the metal. (4) Extrusion program with Northrup, Inc., is aimed at finding a way to extrude complex beryllium shapes.

A million-lb./yr. beryllium market is only two to three years away, most observers believe. But even then a price of $25/lb. "for simple shapes" is the lowest that can be foreseen.

▶ **Columbium: Fast Growth**—Columbium, like beryllium, is in for substantial growth in the next five years, although part of this large percentage growth is accounted for by the fact that columbium is starting from scratch (30,000 lb. in 1958). Columbium capacity is still three to five times greater than the estimated 50,000-lb./yr. market in 1959. Market predictions range from around 150,000 lb. in 1961 to 20 million lb. in 1970.

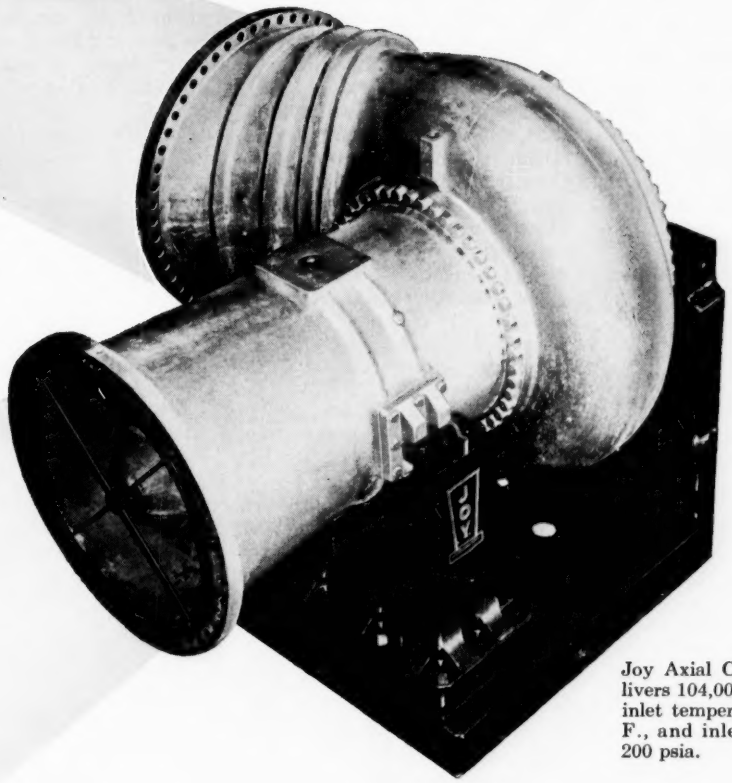
Major reason for this bullish outlook is columbium's nuclear and high-temperature properties. Some of the new Fansteel, General Electric and Du Pont alloys can be used over 2,000 F. Some industry men talk of extending the use temperature to 3,000 F.—although most seem to agree that 2,500 F. will be the limit.

▶ **Turbine Market**—Biggest potential for columbium alloys is in turbines: General Electric and Pratt & Whitney are both experimenting with Cb-alloy turbines that would operate at 2,000-2,500 F., greatly increasing the turbine efficiency. If the columbium-clad fuel element proves practical, another big market will open up.

Blocking columbium's wider

Joy Design Means:

HIGH EFFICIENCY IN THE COMPRESSION OF HOT GASES



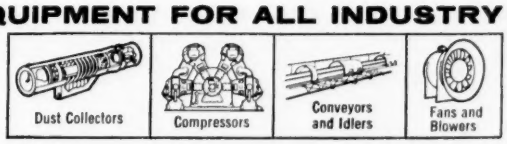
Joy Axial Compressor delivers 104,000 SCFM, with inlet temperature of 1100° F., and inlet pressure of 200 psia.

The special problems posed by high inlet temperatures and pressures are routine to the designers of Joy's advanced axial and centrifugal compressors. Joy dynamic compressors provide economical solutions while achieving high efficiencies. Advanced aerodynamic principles are applied to obtain higher stage performance, whatever the inlet temperature and pressure conditions may be.

Joy dynamic compressors are available in sizes from 15 to 15000 hp for handling air or gases. Expansion turbines and complete process systems can be designed to your specifications. In addition, Joy can furnish positive-displacement type compressors with ratings from 15 to 1250 hp. Whatever your air or gas compression problem may be, Joy can supply the answer.

For complete information on Joy Dynamic Compressors, write for Bulletin 922-11.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

use now is a combination of three factors: High price ($55/lb.), tendency to oxidize and the lack of knowledge on how to fabricate its alloys. Alloying elements like tantalum and tungsten improve oxidation resistance, but no one alloy is entirely satisfactory and coatings may be necessary for long life in oxidizing environments.

As for price, some feel that with a ten-fold increase in production, price could be slashed to $9/lb. Others believe that achievement of this price level depends on new extraction and reduction processes. One of the most significant developments in columbium fabricating has been the advent of the electron-beam furnace (*Chem. Eng.*, July 13, 1959, pp. 80-82) which produces high-purity, ductile columbium metal.

▶**Industry Is Cautious**—The industry picture on columbium is quite turbulent at the present time. Many companies smell big potential profits in the offing—but they are afraid of the large excess capacity that exists.

Wah Chang's plant at Albany, Ore., for instance, can easily supply twice the entire market demand today—and there are at least six other companies that can be termed "major factors" in columbium.

Du Pont, for example, is building a multimillion-dollar high-temperature metals laboratory and has acquired Cb reserves in Colorado—but will not definitely say it is planning a commercial venture. Du Pont's facilities (which use an undisclosed process) are tagged "semi-commercial." U. S. Industrial Chemicals has piloted its own Cb-Ta process in cooperation with Mallory Sharon (based on the sodium reduction work on titanium) but has shelved the process temporarily because of the already overcrowded field.

Stauffer Chemical, with its tie-in with Stauffer-Temescal's electron-beam furnace, has a new 960,000-lb. yr. Cb-Ta pentachlorides plant at Richmond, Calif., utilizing its own chloride distillation process. But with all the requirements, except a reduction step, to become a fully integrated Cb producer, Stauffer will still not definitely say that it is planning a commercial move into the metal.

▶**Molybdenum Disappoints**—Molybdenum is losing some of the glamor it had two or three years ago when it was being touted as *the* metal of the space age. Leading to moly's fall: Although millions have been spent on research, no satisfactory way has been found to eliminate moly's catastrophic oxidation at high temperatures. Coating systems, such as the chromium diffusion coating of Chromalloy Corp., are effective under certain conditions. But under high stress the coating will crack—and once a crack develops, the molybdenum beneath vaporizes.

On the other hand, moly is finding use in missiles where long life is not a factor, e.g., jetavators and nozzles for solid-fuel rocket motors. Too, moly has good corrosion resistance to non-oxidizing chemicals, which may lead to applications in the chemical industry.

▶**Chemical Corrosion**—Climax Molybdenum reports that one petrochemical plant has installed molybdenum valves for handling H_2SO_4 at 400 F. Heat exchangers for handling molten metals have been built for the AEC. Within the next decade, there's a good chance moly will find a place alongside tantalum for special corrosion applications in the CPI.

As for moly's future as a high-temperature material of construction, it is tied pretty closely to the acceptance of those solid-fuel rockets where moly has won a place.

▶**Tantalum: Short Supply**—Tantalum's metallurgy is the most advanced of the refractory metals, but its growth prospects are the least attractive—partly because it is relatively well established already. Its main outlet is for electronic capacitors, although tantalum heat exchangers and reactors find limited use in the CPI.

Tantalum's biggest drawback is the limited amount that is available in the earth's crust; this precludes any high-volume uses. Too, its price ($65/lb.) and density are higher than its sister metal, columbium, which pretty much rules out any big applications in missiles.

▶**Promising Alloys**—Much interest is being generated, however, by new tantalum-tungsten alloys. Fansteel has its Tantaloy (92.5% Ta, 7.5% W) which it is offering commercially. National Research Corp. announces it has developed a Ta-W alloy under Navy contract that can be used at 2,750 F. and may find applications in rocket nozzles and in leading edges of airframes.

Stauffer-Temescal, working with Aerojet-General, the prime contractor for the Navy's Polaris missile, has come up with a 90% Ta, 10% W alloy which will be used for rocket nozzles in operational missiles. The 90-10 alloy, according to Stauffer-Temescal, is as strong as tungsten up to 4,500 F., is much more resistant to oxidation than tungsten, and after electron-beam melting is readily fabricated using conventional steel-working techniques. Price for ingots of this alloy is around $51.50/lb.

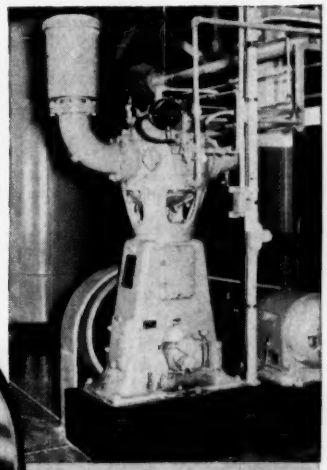
▶**Tungsten: Hard to Work**—Tungsten is the most exciting of the refractory metals because it has the highest melting point. But it has two drawbacks: high specific gravity (19.3) and fabrication problems. Since most tungsten produced now goes into other than high-temperature applications, it will be a long time before any of these new potential uses show up as increased tungsten production.

Main research effort on tungsten today is on new alloys and new fabricating techniques. Fansteel has developed hot forging (3,000 F.), machining and spinning procedures—billed as a "breakthrough"—and has been producing simple shapes such as rocket nozzles (see *Chem. Eng.*, June 1, 1959, p. 54). Stauffer-Temescal has produced ductile tungsten in its electron-beam furnace, but little data is yet available on this form of the metal. Kennecott has produced ductile tungsten alloys by combining with 50% rhenium.

Alloyd Research Corp. says it has been coating tungsten on complex shapes by vapor-phase deposition (under Navy contract). With this procedure, parts can receive tungsten's protection without the weight of solid tungsten.

Joy Design Means:

CHROME-PLATED CYLINDER WALLS FOR CORROSION RESISTANCE



Joy WGO-9 Compressors supply instrument air in southwestern power station.

Chrome-plated cylinder walls give Joy Oil-Free Compressors longer service life and lower maintenance costs. The intermittant duty typical of oil-free compressor service makes rusting of the cylinders a prime source of trouble. Because of the exclusive replaceable cylinder liner construction, Joy is able to put a chrome face on the cylinder wall which will resist corrosion and also give extra wear. This feature and the exclusive T-Block carbon-graphite compression ring construction make Joy Oil-Free Compressors economical to operate.

Joy can supply positive displacement machines with capacities up to 7392 CFM and dynamic machines in any size desired. For complete details on how to get truly low cost, oil-free air, consult your Joy representative, or write for Bulletin 926-11.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY

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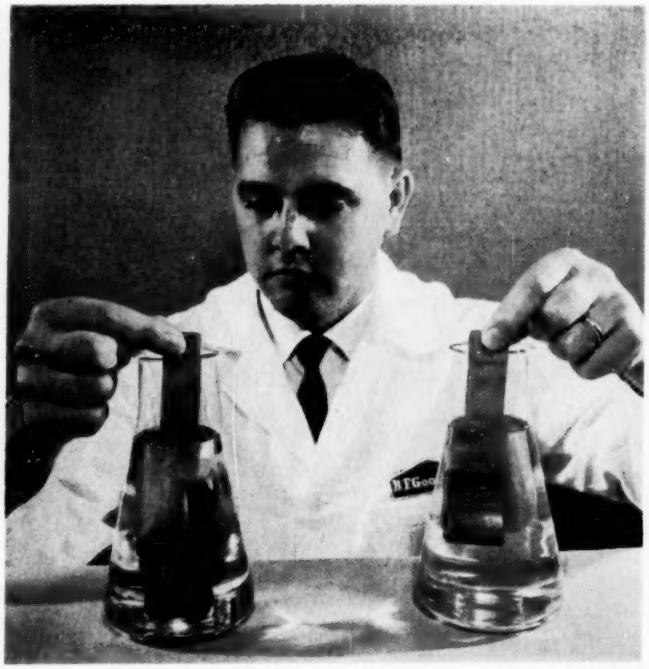
DEVELOPMENTS . . .

CHEMICAL PRODUCTS EDITED BY FRANCES ARNE



Treated Nonwoven Fabric, Right, Stands Dry Cleaning

A nonwoven fabric, right, treated with a new acrylic latex is not affected by dry cleaning solvents which rapidly deteriorate nonwoven fabrics treated with conventional binders, left. Aim is to allow expansion of nonwovens into outerwear.

Tests show that the new latex simplifies compounding, reduces processing cost, increases stability and provides the washability —as well as the dry-cleanability —that have been major obstacles in using this type of construction for outerwear.

Ultimate result might be such extremely low-cost fabrics that you could buy a suit, wear it until it became wrinkled and throw it away.—B. F. Goodrich Chemical Co., Cleveland. 42A

Alkyd Resin

Basis for enamels that dry as quickly as lacquers.

A rapid air-dry resin for industrial top coats that sets tack free in about five minutes and hardens into a tough, glossy finish without baking has been developed.

The new resin, Aroplaz 6006, is a pure, oxidizing, oil-modified alkyd, a short oil soya composition.

The five-minute tack-free drying time of Aroplaz 6006 compares with ten minutes for a very fast styrenated alkyd and thirty minutes for a very fast pure alkyd.

The product exhibits desirable pure soya alkyd features of high solids formulation, solvent resistance, color and color retention and durability. Mar resistance is unusually good.

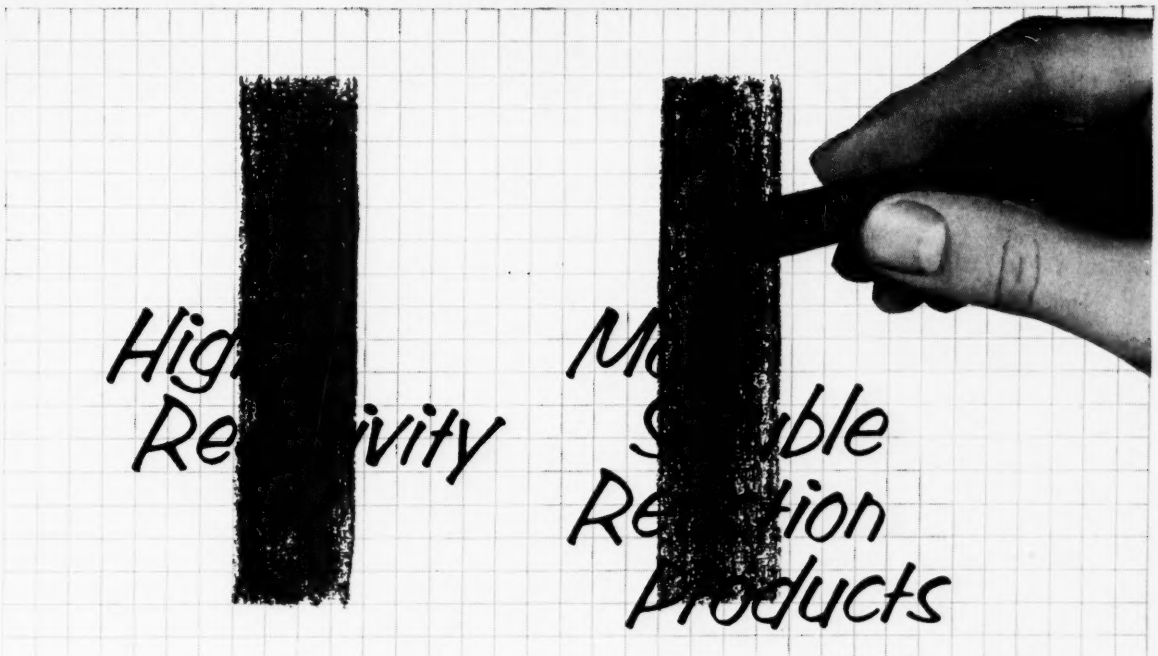
Although its greatest advantage over existing vehicles is its ability to dry with the speed of lacquer, it also performs spectacularly in low temperature forced dry (150-150 F.) or high temperature baking (300-350 F.), producing a hard, slick finish. Because of wide compatibility with alkyds, other resinous materials and aliphatic solvents, enamels can be tailored to meet diversified requirements.

Specifications

Solids (±)	50
Solvent	Xylol
Viscosity (G-H @ 25 C.)	W-Y
Viscosity (Stokes @ 25 C.)	10.7–17.6
Acid value-solids	6–10
Color (Gardner 1953)	6 max.
Lb./gal.-soln.-av.	9.2
Lb./gal.-solids-av.	9.6
Rosin or derivatives	None
Phenolic modification	None

Properties indicate that Aroplaz 6006 will find use in numerous high quality air dried and baked industrial finishes for implements and machinery, hardware, automotive refinishing, cabinets, and in metal primers, lacquers and aerosols.

Its use in finishes can speed assembly line operations by many valuable hours, since products coming off the line can be handled and moved a few minutes after painting. Because Aroplaz 6006 combines readily with other film formers, it can be used to pep up the air drying and baking properties of conventional formulations without causing brittleness, loss of dur-



You get BOTH in all 6 forms of

SOLVAY CAUSTIC POTASH

When you start with a more reactive material like Solvay® Caustic Potash, you usually get better results. Many users prefer it to caustic soda because it enables them to produce more soluble reaction products and less viscous solutions.

For example, its high solubility permits liquid end products having high soap concentration. Many heavy-duty liquid detergents would not exist were it not for ingredients derived from caustic potash.

Its high reactivity is also useful in mercaptan extraction and desulfurization of petroleum products. Caustic potash solutions effectively absorb carbon dioxide and hydrogen sulfide in industrial gases. Dry forms are highly hygroscopic, excellent for dehydration.

Sodium Nitrite • Calcium Chloride • Chlorine • Caustic Soda • Caustic Potash
Potassium Carbonate • Sodium Bicarbonate • Chloroform • Methyl Chloride
Soda Ash • Vinyl Chloride • Ammonium Chloride • Methylene Chloride • Carbon
Tetrachloride • Snowflake® Crystals • Monochlorobenzene • Ortho-dichlorobenzene
Para-dichlorobenzene • Ammonium Bicarbonate • Hydrogen Peroxide • Aluminum
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61 Broadway, New York 6, N. Y.

SOLVAY branch offices and dealers are located in major centers from coast to coast.

Mail the coupon for samples and *new* Solvay Technical Bulletin crammed with facts, tables, diagrams for applying caustic potash.

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Please send me without cost:

Samples of Technical Grade Caustic Potash
☐ Flake ☐ Small Flake ☐ Solid
☐ Ground ☐ Liquid, 45% strength
☐ Liquid, 49-50% strength

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☐ Flake ☐ Liquid, 45% strength

☐ New Technical Bulletin 15, Caustic Potash

Name _____

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Company _____

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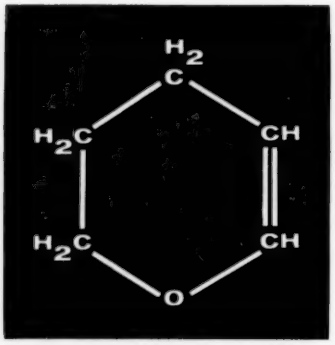
ability or destruction of color retention and gloss.

Not only does Aroplaz 6006 have a higher solids-viscosity ratio than lacquer, but it is much more economical since it does not require expensive solvents.

Accelerated weather tests of Aroplaz 6006 finishes indicate that its performance compares well with baked melamine alkyd enamels. Mar, gasoline and solvent resistance surpasses that of styrenated alkyds.

Enamels in every color from white to black and including metallics can be made with Aroplaz 6006. — **Archer - Daniels - Midland Co., Minneapolis.** 42B



Dihydropyran

Reactive double bond produces many useful chemical intermediates.

Dihydropyran (2,3-dihydro-4-H-pyran) is now available in drum quantities, made by a new catalytic process at the company's pilot plant in Memphis.

A colorless liquid, it is very reactive, the activity being centered around the double bond. The reaction products are numerous and many are useful as chemical intermediates.

Alcohols, in presence of acids, add readily to the double bond of dihydropyran; thus, the addition of methanol forms 2-methoxytetrahydropyran, an acetal from which the alcohol and dihydropyran are readily regenerated. This is a useful method to protect alcoholic hydroxyl groups in certain reactions.

Dihydropyran exhibits properties of vinyl ether. It adds hydrochloric and hydrobromic acids to form the corresponding 2-halotetrahydropyran.

Dihydropyran as a pure compound has a boiling point of 84.3 C. at 760 mm., a freezing point of −70 C., and a flash point of 0 F. It forms a water azeotrope of 9.8% water boiling at 71-72 C.—**Quaker Oats Co., Chicago.** 44A

Water Soluble Resin

For water-solution baking enamel for automotive and industrial finishing.

Only pigment and water need be added to a new melamine-acrylic resin for industrial and automotive finishes. Now being marketed to paint manufacturers, the resin is called Melaqua 600.

Properties	
Solids % by weight	50±2
Color, Gardner, max	7
Viscosity	Z_6-Z_8
Lb./gal., approx	8.8
H	9.5–10.0

The cured resin film, an acrylic polymer cross linked with melamine resin, embodies many of the favorable characteristics of both these resin types. Melaqua resin 600 enamels are said to be actually superior in many respects to the highest quality melamine resin, non-oxidizing alkyd formulations. They show the following outstanding properties: excellent liquid enamel stability; exceptionally good flow and leveling with lack of orange peels; colors are cleaner and brighter than solvent-type amino-alkyd formulations with the same pigmentation.

Also claimed for the enamels: high gloss; freedom from cratering tendencies; excellent overspray absorption; excellent initial color and color retention under both heat and light; excellent durability with no embrittlement on prolonged outdoor exposure; excellent color and gloss retention on overbake. —**American Cyanamid Co., New York.** 44B

Fluorinated Rubber

New version of elastomer performs in high heat even better than before.

Development of a new version of Du Pont's heat- and fluid-resistant fluorinated hydrocarbon rubber, Viton, has doubled the product's useful life at tem-

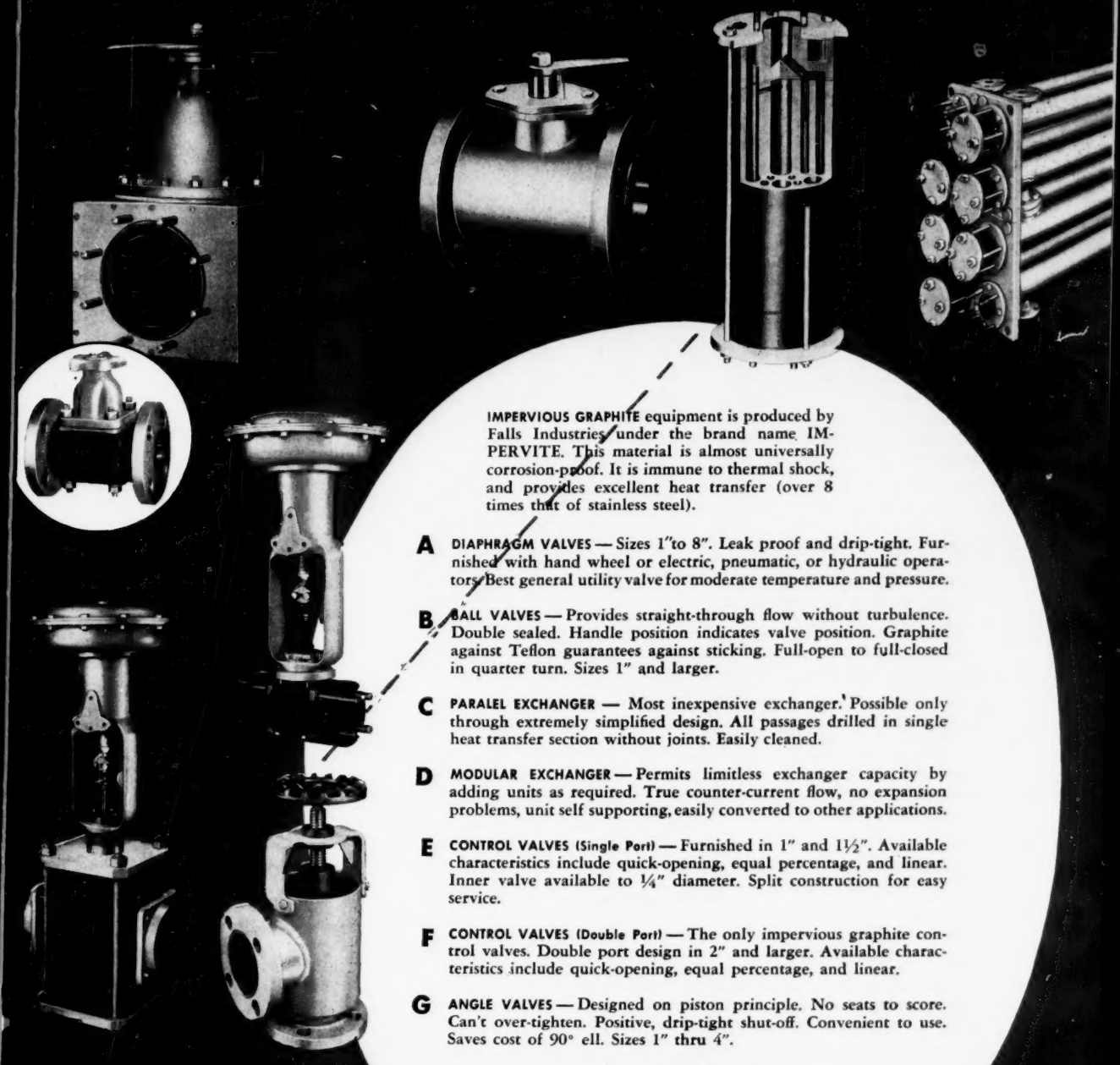
Newsworthy Chemicals

Page Number is also Reader Service Code Number

Acrylic latex treatment upgrades nonwoven fabric..... 42A
Alkyd resin base for very quick drying enamels..... 42B
Dihydropyran, reactive intermediate, now available..... 44A
Acrylic-melamine resin for water-solution enamels..... 44B
Fluorinated rubber, more heat, oil resistant than ever.... 44C
Copolymer emulsion benefits adhesives, coatings..... 46A
Antibiotic excels tetracycline..... 46B
Heavy-gage polyethylene sheet, first of its kind..... 46C
Two organotins catalyze one-shot urethane foaming..... 46D
Synthetic penicillin now available..... 46E
PVAc latex paint tackles exterior wood..... 46F
Nickel base catalyst ups reforming efficiency..... 46G
Two cyclobutane compounds in development quantities.. 46H

For more details, use Reader Service Card

. . . more new impervious graphite equipment from FALLS FI INDUSTRIES



IMPERVIOUS GRAPHITE equipment is produced by Falls Industries under the brand name IMPERVITE. This material is almost universally corrosion-proof. It is immune to thermal shock, and provides excellent heat transfer (over 8 times that of stainless steel).

A **DIAPHRAGM VALVES** — Sizes 1"to 8". Leak proof and drip-tight. Furnished with hand wheel or electric, pneumatic, or hydraulic operators. Best general utility valve for moderate temperature and pressure.

B **BALL VALVES** — Provides straight-through flow without turbulence. Double sealed. Handle position indicates valve position. Graphite against Teflon guarantees against sticking. Full-open to full-closed in quarter turn. Sizes 1" and larger.

C **PARALEL EXCHANGER** — Most inexpensive exchanger. Possible only through extremely simplified design. All passages drilled in single heat transfer section without joints. Easily cleaned.

D **MODULAR EXCHANGER** — Permits limitless exchanger capacity by adding units as required. True counter-current flow, no expansion problems, unit self supporting, easily converted to other applications.

E **CONTROL VALVES (Single Port)** — Furnished in 1" and 1½". Available characteristics include quick-opening, equal percentage, and linear. Inner valve available to ¼" diameter. Split construction for easy service.

F **CONTROL VALVES (Double Port)** — The only impervious graphite control valves. Double port design in 2" and larger. Available characteristics include quick-opening, equal percentage, and linear.

G **ANGLE VALVES** — Designed on piston principle. No seats to score. Can't over-tighten. Positive, drip-tight shut-off. Convenient to use. Saves cost of 90° ell. Sizes 1" thru 4".

DRAIN VALVES (not illustrated) — Designed expressly to eliminate possible clogging of drain outlets in tanks. Provides automatic clearing of outlets. Sizes 2", 3" and 4".

FALLS FI INDUSTRIES, INC.
AURORA ROAD — SOLON, OHIO
Phone: CHurchill 8-4343 — TWX: CV-720

peratures from 500 to 600 F. and in certain strong chemicals.

The new version can be used in molded goods and coated fabrics. Tests at 500 to 600 F. show that useful elasticity is retained up to twice as long. Resistance to special lubricants and hydraulic fluids used in missiles and high-speed aircraft is improved, and useful life is prolonged in the presence of such harsh chemicals as red fuming nitric acid.

Development of the higher performance type of Viton is expected to broaden the range of use of the fluorine-containing elastomers. Since their introduction early in 1958, they have been widely adopted for aircraft and missile parts and in a variety of commercial applications in automotive uses, oil well equipment, chemical processing equipment.—**Du Pont Co., Wilmington.** 44C

Copolymer Emulsion

For manufacturing and end-product benefits in adhesives, coatings.

Production of a new borax-stable polyvinyl acetate-dibutyl maleate copolymer emulsion has been announced.

Designated Resin D-243, the emulsion is said to be unique because it combines borax tolerance with a high degree of compatibility with organic solvents.

The product has a particle size distribution of from 0.2 to 1.5. In addition, it is reported to have superior flow characteristics, excellent freeze-thaw and mechanical stability.

Films cast from it have the advantages usually associated with internal plasticization such as improved film forming characteristics and low temperature flexibility without the need for more plasticization.

Resin D-243 is suggested particularly for use in adhesives, and also in textile finishing, as a cement additive, in paper coatings, surface coatings and as a beater additive in paper manufacture.—**Shawinigan Resins, Springfield, Mass.** 46A

Antibiotic

Excels tetracycline in germ-killing effectiveness.

A new antibiotic is said to have greater and more prolonged germ-killing effectiveness than tetracycline, currently the most widely used broad spectrum antibiotic in the United States.

The new antibiotic, Declomycin demethylchlortetracycline, was produced by an offspring of the organism from which Aureomycin chlortetracycline was isolated.

According to investigators Declomycin is longer acting and requires a lower dose than other tetracyclines, while maintaining a similar disease control range. Within six hours after administration, the amount of the older tetracycline-type antibiotics in the patient's blood has diminished greatly. Declomycin, however, has been shown to retain antibacterial activity in the blood from 24 to 48 hr. after treatment is discontinued. Declomycin's longer activity may be due to its greater stability in body fluids than previous tetracyclines.—**American Cyanamid Co., Lederle Laboratories Div., Pearl River, N. Y.** 46B

BRIEFS

Heavy-gage polyethylene sheeting, available seamless and in wide widths, represents the latest advances in extrusion techniques, is believed to be the first of its kind. Called Ger-Pak, it comes in maximum 15-in. thickness.—**Gering Plastics Div., Studebaker-Packard Corp., Kenilworth, N. J.** 46C

For More Information about any item in this department, circle its code number on the **Reader Service** postcard (p. 147)

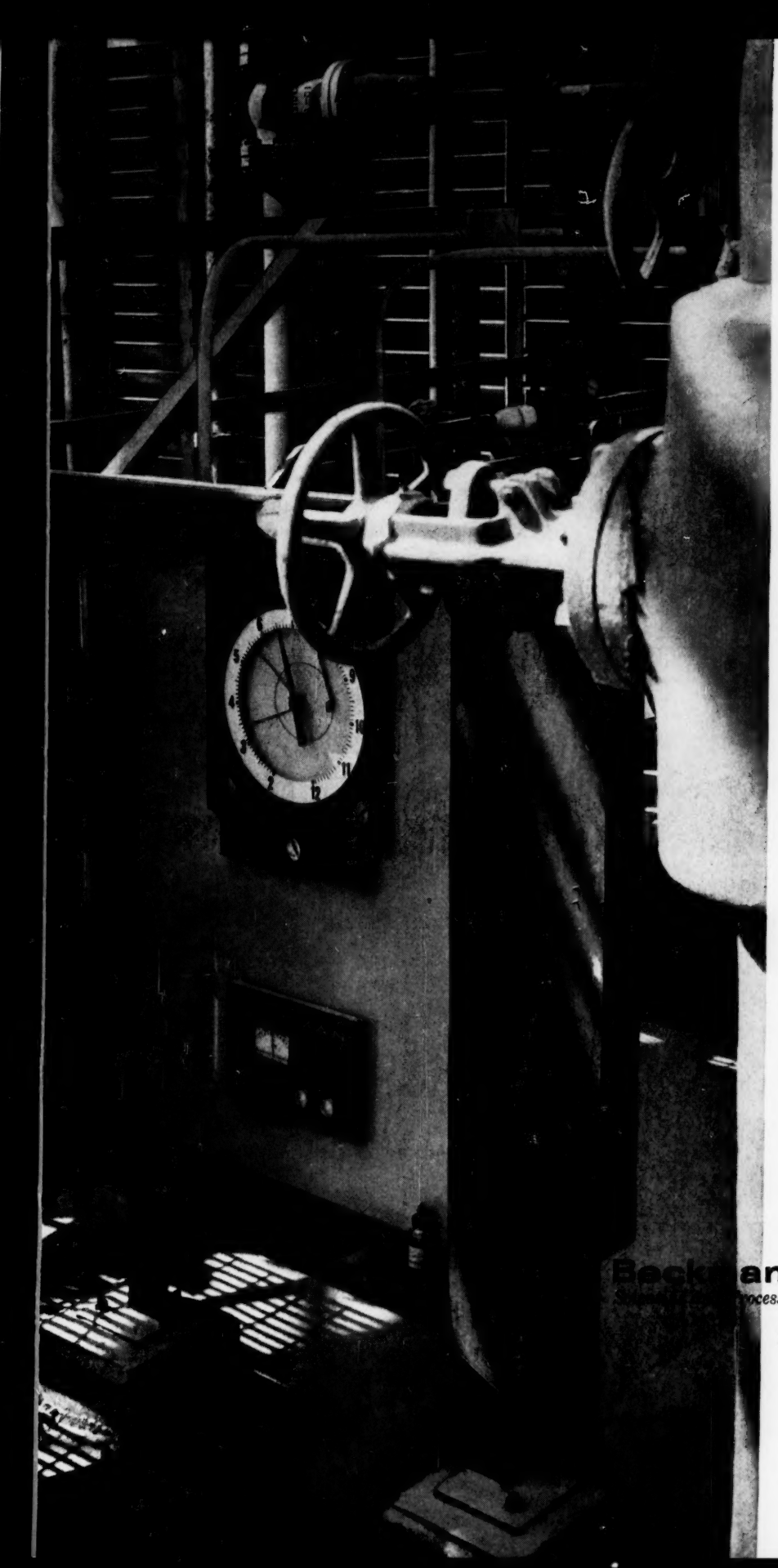
Two organotins, dibutyltin di-2-ethylhexoate and dibutyltin dilaurate, and two inorganic tin compounds, stannous octoate and stannous oleate, are now available for use as catalysts for one-shot urethane foams.—**Metal & Thermit Corp., Rahway, N. J.** 46D

Synthetically-modified penicillin, called Maxipen, produces blood levels several times higher than the highest now available with the original penicillins or their modifications. Level of an antibiotic in the blood stream is the doctor's usual assurance that the drug is reaching the site of infection in the body.—**Chas. Pfizer & Co., New York.** 46E

PVAc latex paint for exterior wood may now be formulated on the basis of new vinyl emulsion, Flexbond 800. Company believes it is the first PVC emulsion producer to go into the house paint market on a fully commercial basis. Paints based on the product are said to equal in performance acrylic latex paints introduced to this market early this year.—**Colton Chemical Co., Cleveland.** 46F

Nickel base catalyst, G-56, is said to increase capacity or improve operating efficiency in reforming of lower molecular weight hydrocarbons. It contains no sulfur and does not require preactivation before being placed on stream. It is not affected by exposure to temperatures as high as 2,200 F. and does not fuse at 2,500. Physical strength is substantially greater than that of previous catalysts of this type.—**Chemetron Corp., Louisville, Ky.** 46G

Two cyclobutane compounds, tetramethyl-1,3-cyclobutanedione and its reduction product 2,2,4,4-tetramethyl-1,3-cyclobutanediol, are now available in development quantities. Heretofore, a practical and economically feasible production method had not been developed.—**Eastman Chemical Products, Inc., New York.** 46H



4 minutes' attention for 24-hour operation

Just 4 minutes a day and a Beckman Model W Industrial pH meter are all it takes for a technician to prevent equipment corrosion by continuous pH control of cooling tower water at Collier Carbon and Chemical Corporation, Brea, California.

⋈ For over two years, this small Beckman pH amplifier has continuously maintained cooling water at a pH of 6, correcting all variations automatically in about 15 seconds. And, except for the few minutes attention required every morning for routine meter standardization, it has provided maintenance-free operation.

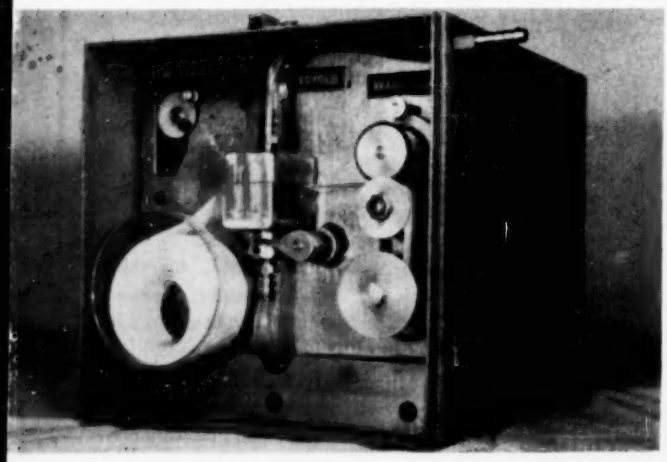
⋈ Beckman pH equipment can also give *you* dependability with minimum attention. The reason: printed circuitry, plug-in assemblies, and ruggedized industrial electrodes.

⋈ Beckman makes and sells more industrial pH equipment than any other manufacturer in the world. Equipment and services are provided by leading recorder companies. For a list of these companies and instrument specifications, write for Data File 14-49-06.

Beckman
Instruments Division
Beckman Instruments, Inc.
2500 Fullerton Road, Fullerton, California

It's a Fact: More than 500,000,000 hours have been logged by Beckman industrial pH meters...measuring and controlling pH in industrial processes.

New Detectors Gang Up on Air Pollution



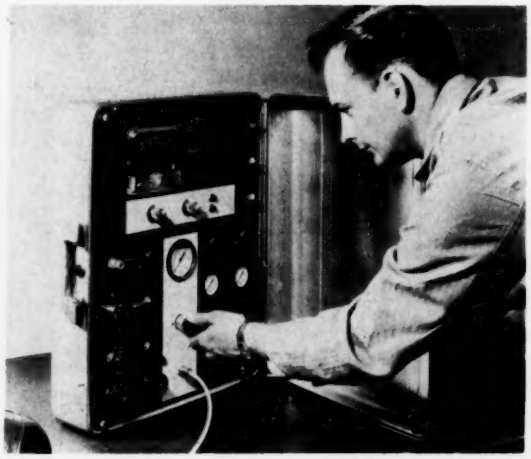
Dust Sampler

To enable quantitative measurement of airborne-dust pollution conditions throughout any plant area, Gelman Instrument Co. has introduced their new paper-tape air sampler.

This portable device will automatically collect up to 900 individual dust samples by intermittently sucking controlled volumes of contaminated air through a paper filtering tape. A sensitive densitometer measures dust concentration as a function of sampling-spot discoloration. Filtering time per sample varies from 5 min. to 2 hr. Monitored air volume per sample adjusts from 1½ to 36 cu. ft.

For special applications, Gelman also offers chemically treated paper tapes that change color in the presence of undesirable gaseous contaminants such as hydrogen sulfide or phosgene. Developed color gives a semiquantitative indication of the contaminant's concentration.

A 1/50-hp. piston pump supplies feed air to the sealed sampling area. Motor-activated ratchets reposition the tapes after each sampling. Cost of the 21-lb. instrument is $235; densitometer price is $99. —**Gelman Instrument Co., Chelsea, Wis.** **48A**



Hydrocarbon Monitor

From Perkin-Elmer comes another portable air-pollution detector—a new monitor that rapidly analyzes gaseous feeds for total organically bonded carbon atoms. Design characteristics make the device also suitable for detection of explosive limits.

In operation, a metered flow of sample feeds into a hydrogen flame within an enclosed chamber. The flame ionizes combustibles to effect changes in current flow of a surrounding electrical field. These changes, which are proportional to total carbon content of the sample, register on the instrument's meter.

Sensitivity runs better than 0.1 ppm. for organics such as aldehydes, ketones, amines, etc. Operating range adjusts from as low as 0-1 ppm. up to 0-10%. Presence of water vapor, oxygen or carbon dioxide in the feed will not interfere with reliability of results.

According to P-E, nontechnical personnel can operate the Model 213 Detector after only 30 min. of instruction. Unit weight is 47 lb., including all batteries and accessories. Size is 18 x 13 x 8 in.— **Perkin-Elmer Corp., Norwalk, Conn.** **48B**

Other significant Equipment Developments on p. 50.

UNIONWELD®

Approved by Industry

OVER 25 MILLION FEET of "UNIONWELD" IN USE THROUGHOUT PROCESS INDUSTRIES ARE YOUR ASSURANCE OF THE CONSISTENT HIGH QUALITY STANDARDS MAINTAINED BY UNION STEEL

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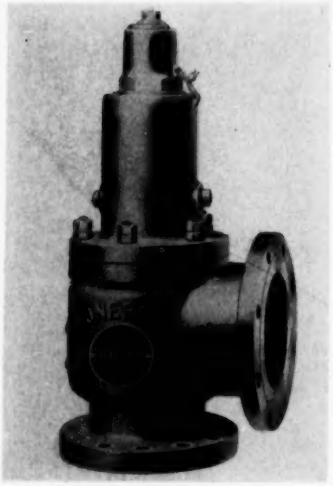
STAINLESS and SPECIALTY STEELS - exclusively



Relief Valves

Stop product waste, reduce maintenance.

Relief valves for liquid service will not drum, chatter or hammer in any application, either bypass or emergency relief, according to the manufacturer. Design does not call for extra springs or other mechanisms. Instead, special throat, seat and baffle construction eliminates hammering nuisance.

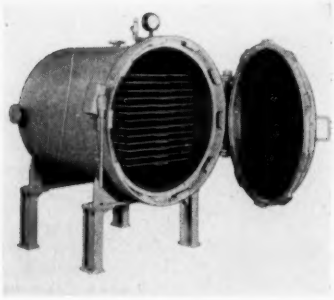
Called Hydro-Valves, the units come with any body or trim materials used by industry. Standard version is available in sizes from 1 to 8 in. A bellows model is offered in 1½- to 8-in. sizes.—**J. E. Lonergan Co., Philadelphia, Pa. 50A**

Chlorination Cell

Pulpmaker's device may find other process uses.

Diamond Alkali's new chlorination cell, a rugged sensing element, is claimed to offer a practical approach to the automatic control of chlorination processes. Developed primarily for pulp manufacturing operations, the instrument is available in two models—a probe for large vessels, and a flow-through unit for line applications.

Actually an oxidation potential sensor, the cell consists of a platinum and a silver electrode imbedded 1 in. apart in an epoxy resin within a cylindrical housing. Rugged design permits use with temperatures to 200 F. at high pressures in the presence of acids or bases and oxidizing or reducing agents. Solid particles or fibers do not hinder proper functioning. Installation is simple.—**Diamond Alkali Co., Cleveland, Ohio. 50B**



Leaf Filter

Horizontal unit features highly accessible leaves.

In addition to conventional, horizontally mounted filter leaves, the new HL leaf filter features an added bottom leaf contoured to the case to assure filtration of all liquid in the tank at the end of a cycle. Media can be either inexpensive filter papers or conventional cloths.

Accessibility of the leaves permits one-man cleaning in 4 to 15 min., depending on size. On-off operation is possible without disturbing filter cake or filtrate clarity. Filter cake may be hosed out without removing the elements.—**Process Filters Div., Bowser, Inc., Fort Wayne, Ind. 50C**

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

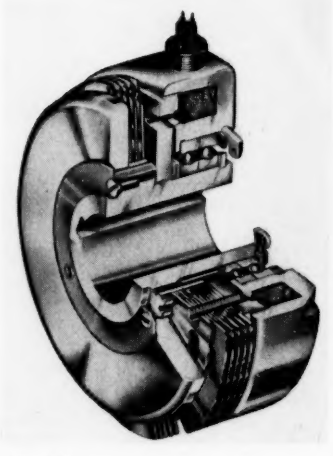
postcard (p. 147)

Bin Controls

Manufacturer introduces three new level guards.

As material level within bins rises or falls, the new Tellevel control will actuate speed conveyors or elevators, or operate warning lights and horns. Each of the three models available is self-contained, and consists of a pendant float that operates a sensitive switch. Lubrication is unnecessary.

Normal-duty Tellevels are useful for light to medium-weight granular material. A heavy-duty model functions best with lumpy materials. Also, an explosion-proof unit is offered for hazardous locations. —**Stephens-Adamson Mfg. Co., Aurora, Ill. 50D**

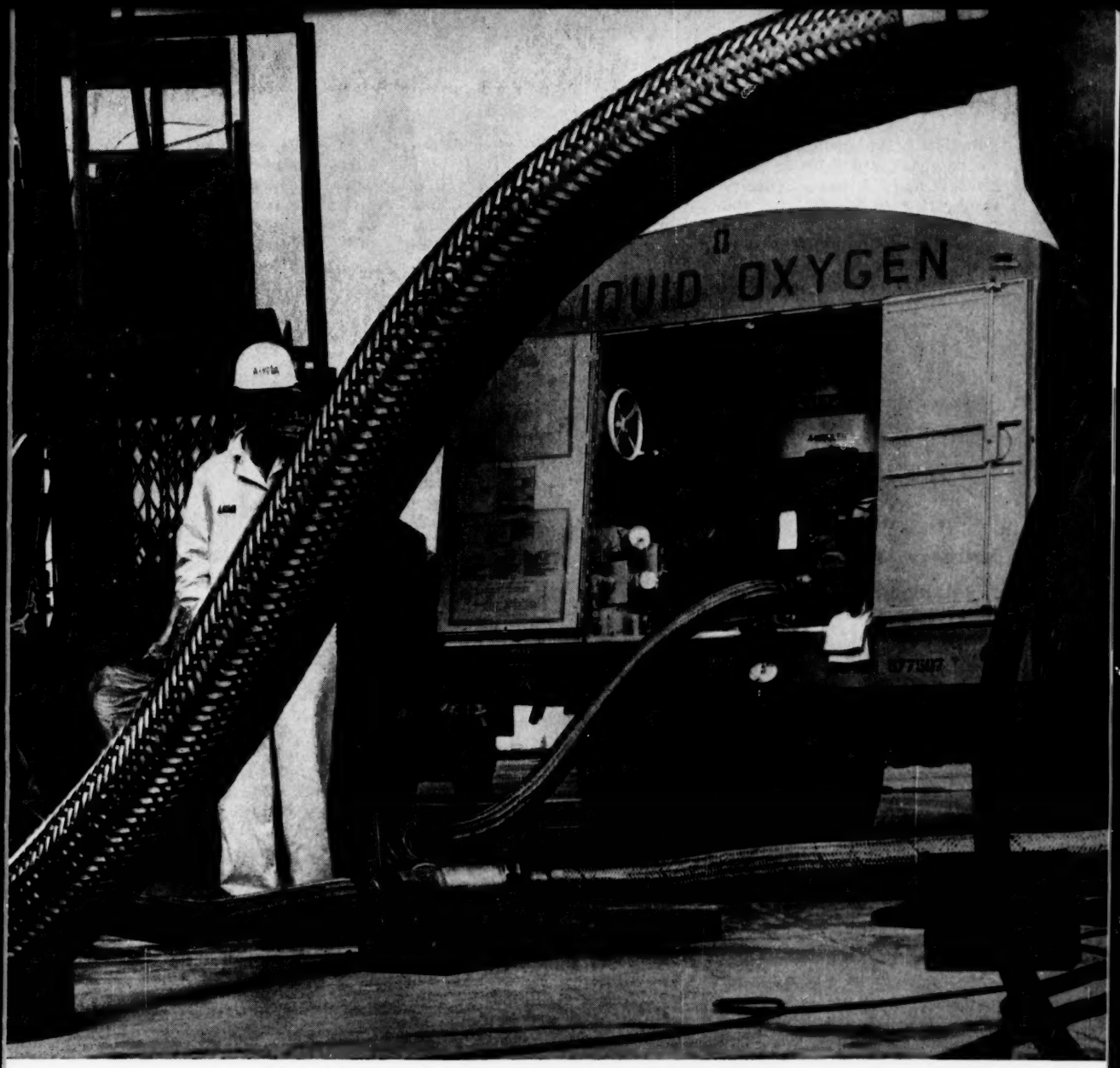


Clutch

Electromagnetic unit for automatic machinery.

Licensed from the German firm of Ortlinghaus, a new, wet-type electromagnetic clutch permits an almost unlimited variety of spindle speeds, feed and traverse movement, and directional changes. Design provides high torque capacity, and assures automatic wear takeup to eliminate adjustment problems.

Features include stationary coils to assure low inertia of rotating masses, antifriction bearings, and a special bronze



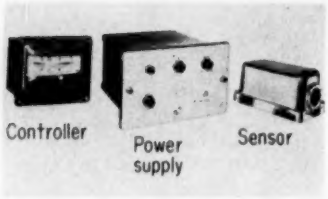
THESE BIG TOUGH HOSE ASSEMBLIES SOAK UP THE SHOCK OF A SWING FROM TROPICAL HEAT TO −303°F IN SECONDS

It takes many heavy-duty flexible metal hose connections to feed liquid oxygen to a missile. In the photo above are four 3½" I.D. metal hose lines of stainless steel manufactured by Anaconda Metal Hose. They connect three tank trucks to the pumping station which fuels Jupiters at the Army's Redstone Arsenal. Similar hoses are used to make connections between the fueling masts and the missile itself, making it unnecessary to align piping precisely. As fuel masts are kicked off the missile at firing, the hose must be able to withstand rough treatment and hot exhaust gases, as well as the wide temperature fluctuations.

FREE TECHNICAL SERVICE. Whether you need big, heavy-duty flexible metal connectors for big, tough jobs or small-diameter flexible metal hose for small, tough jobs, Anaconda Metal Hose Division welcomes the opportunity to help you meet your problems of expansion and contraction, movement, vibration, corrosion, pressures, and temperatures. Equipped to work in stainless steel, Monel, and aluminum as well as other alloy steels and copper alloys, Anaconda specialists are constantly working with design engineers on flexible connector assemblies to meet new problems. For further information or engineering assistance, call your Anaconda Metal Hose representative or write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 59131

ANACONDA®
METAL HOSE

hub that prevents flux leakage to the shaft. Available in eight sizes, Model KA has a capacity range of ¼ to 34½ hp. (at 100 rpm.) with maximum torque ratings of 14.5 to 1,812 lb.-ft.—**Twin Disc Clutch Co., Racine, Wis.** 50E



Infrared Detector

Being demonstrated at the Chem Show this week.

Utilizing advanced methods of infrared detection, the new Thermodot radiation thermometer automatically measures and controls temperature of moving or stationary objects, without physical contact. Applications include measurement of inaccessible surface temperatures, nondestructive testing, assembly-line inspection, etc.

Infrared radiation received by Thermodot translates into a signal voltage, which is amplified to a level sufficient to drive an indicator calibrated directly in temperature. Sensitivity is 7 deg. at 2,000 F., and instrument response is rapid and accurate. Lowest standard operating range is 180 to 400 F.; highest is 700 to 2,000 F. Indicators, controllers or recording potentiometers are available.—**Radiation Electronics Co., Chicago, Ill.** 52A

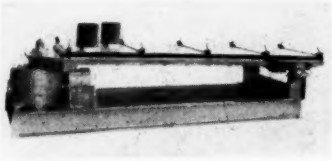
Protective Coatings

Three manufacturers introduce new products.

According to company officials, a new stainless steel paint, No. 13448, has a life expectancy of at least 12 yr. Paint composition is a mixture of stainless steel flakes, nonmetallic pigments and a long-oil alkyd vehicle. While cost is approximately twice that of conventional quality products, it is estimated that consumers can look forward to savings of 30% or more as a result of maintenance savings.—**Vita-Var Corp., Newark, N. J.** 52B

Another new system of protective coatings known as Farboil Epothane has been developed to protect equipment from chemicals, abrasion and impact. Features include an air-cured, glasslike finish and ease of application by brush, roller or spray. The coatings cure to 75% of the hardness of glass, yet do not become brittle. Odorless and nontoxic.—**The Farboil Co., Baltimore, Md.** 52C

A third company announces availability of newly developed Prufcoat Primastic, a protective coating that combines rust-inhibitive primer qualities with the chemical resistance of a catalyzed epoxy coating. One crosspass spray coat yields 20-mil dry-film thickness. Cost per mil-ft. is about 1¢. Flashpoint exceeds 100 F.—**Prufcoat Laboratories, Cambridge, Mass.** 52D



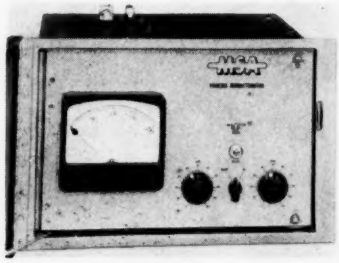
Solids Cooler

Self-contained unit has high heat-transfer rate.

Rotex coolers, new surface-contact machines for cooling particulate materials on a production basis, will be exhibited for the first time at this week's Chem Show. Circulation of water through a baffled jacket beneath the flat particle-supporting surface provides cooling effect.

In operation, the cooling surface moves with a horizontal, gyratory motion at the feed end, diminishing to an approximate straight-line motion at the discharge end. Such action uniformly spreads materials over the entire cooling surface.

In place, the top cover assures dust-tight operation; when removed, the cover exposes the cooler's interior for fast cleaning. Primary material of construction is stainless steel. — **The Orville Simpson Co., Cincinnati, Ohio.** 52E



Process Refractometer

Aid to stabilization of product quality.

A new process refractometer for automatic, continuous measurement and control features range flexibility, easy conversion to new problems and rapid response. Operating principal involves measurement of variations in refractive indices between the substance analyzed and a constant standard.

Measurement ranges vary from 0-1% to 0-100%. Readings for 90% of full-scale deflection take only 30 to 60 sec. Construction features unitized design of the amplifier, optical bench and control unit.—**Mine Safety Appliances, Pittsburgh, Pa.** 52F

Color Monitor

Can control processes to preset color standards.

Compact and light in weight, a new electronic color monitor and control unit is capable of displaying information revealing variations in hue and intensity of light received from test

EQUIPMENT NEWS
Continues on . . Page 130

Which valve alloy for your next job?

When you next have a requirement for high alloy valves, especially for corrosion service, why not come to the company with the most experience in this field.

Aloyco has specialized in the manufacture of stainless steel valves, exclusively, for over 30 years.

We have accumulated a wealth of know-how, not only on how to engineer valves for hard-to-handle corrosives, but also on what alloys are the most efficient and will give the longest life.

Aloyco's field consulting service is yours for the asking. Why not write or call our nearest sales office for help on your next alloy valve job. Alloy Steel Products Company, 1301 West Elizabeth Avenue, Linden, New Jersey. 9.10

Offices in: Boston • New York • Wilmington Atlanta • Buffalo • Pittsburgh • Chicago St. Louis • San Francisco • Los Angeles

***These seven corrosion test specimens** are just a few from hundreds of tests conducted by Aloyco to insure our valve customers of the right alloy for their particular job. Aloyco valves are supplied in such metals as 304 and 316 stainless steel, Aloyco 20, Nickel, Monel and Hastelloy B, C and D.*

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SUBSIDIARY OF WALWORTH

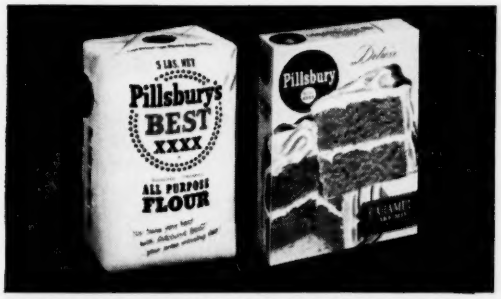
ALLOY STEEL PRODUCTS COMPANY
LINDEN, N. J.

CYANAMID

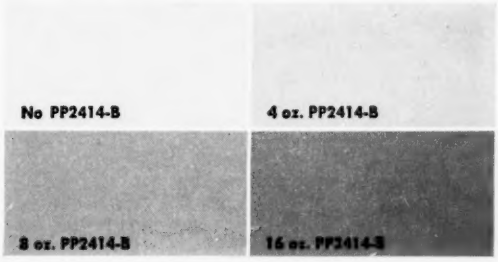
Chemical Newsfront

BOON TO BATHING BEAUTIES. Cyanamid's ANTIOXIDANT 425® works ceaselessly to protect clean, white, strong rubber thread—essential component of bathing suits and other "stretch" garments—against the loss of elasticity- and strength-sapping ravages of oxygen. Unrivaled in its non-staining characteristics, Antioxidant 425 also assures the ultimate in long-lasting whiteness.

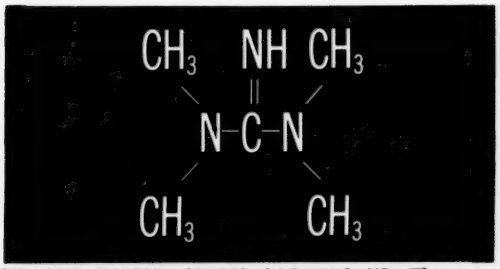
(Rubber Chemicals Department)



PILLSBURY PACKAGES PACK NEW PUNCH. In the hot war for supermarket shelf space, these two Pillsbury packages have scored an impressive victory by adding Cyanamid's CALCOFLUOR® White brightener to the paper and board stock. The whiter white base that Calcofluor provides makes package colors sing and printing pop. With a zestful look of added quality and cleanliness, Calcofluor treated packages demand shelf exposure... invite faster impulse buying. (Dyes Department)



NEW PRODUCT AIDS PAPER INDUSTRY. Cyanamid's Paper Product 2414-B, a water soluble polyacrylamide resin, is now being used in the paper industry to improve the retention of fines and pigments. In addition to reducing costly waste of pigments, other benefits are: more even coloring on both sides of the sheet, faster machine drainage, and less stream pollution from pigments. Its effectiveness as a pigment retention aid is demonstrated in the photo above. The four handsheets contain equal amounts of colored pigment while the PP2414-B content varies from zero to 16 ozs. per ton of paper as indicated. Conversely, color specifications may be maintained by the addition of PP2414-B in appropriate amounts while reducing the pigment content. (Paper Chemicals Department)



TONGUE-TWISTER STARTS GROWING UP. This is a significant year for Cyanamid's *Tetramethylguanidine* (TMG). Last year, the formula for TMG appeared here as a new chemical available for research only. Now it may be ordered in drum quantities. TMG is a liquid with a slight ammoniacal odor. It boils at 159-160°C and is soluble both in water and organic solvents. Chemists in need of a strong, all-organic base should find these properties worth evaluating. (Market Development Department)

CYANAMID

AMERICAN CYANAMID COMPANY

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NEWS AT A GLANCE...

Cyanamid's new liquid paper dye, Green MX Liquid, eliminates dusting and handling problems resulting from the use of some powdered dyes...Better uranium mining yields now possible with Cyanamid's new Superfloc 16 flocculant. By binding together tiny ore particles, Superfloc 16* forms larger ones that settle out of suspension more easily...Improved process for manufacturing Melamine will be utilized at Cyanamid's new Wallingford, Conn., plant. Now under construction, plant is expected to be in operation by early 1960...Fish processors and consumers will benefit from application of Cyanamid's Acronize® chlortetracycline to fish. Recently accepted by the government for use on vertebrate fish, unpeeled shrimp and shucked scallops, Acronize appreciably extends their fresh-caught flavor... Formica Corporation builds new research and product development laboratory at Evendale, Ohio. The new facility, scheduled for completion by spring 1960, will increase Formica's research-development activity 40%. Formica Corporation is a Cyanamid subsidiary.

* Trademark

For further information on products in this advertisement wire, phone—or mail this coupon to:

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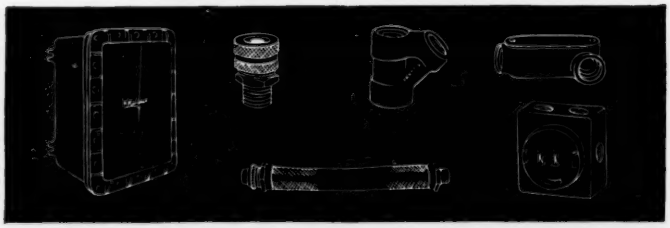
Killark manufactures a complete line of UL and CSA approved Explosion-Proof, Vapor-Proof and Dust-Tight fittings and fixtures.

Write for the Killark Catalog of Electrical Fittings and Fixtures

the cross section tells the story

The slice across the cast iron fitting above quickly shows you why a coating or plating is only temporary protection at best. Regardless of how well and how carefully applied, this surface requires only the slightest scratch or nick to open the door to expensive rust and corrosion.

The Killark Electrolet is solid aluminum, alloyed with other metals to give strength and ductility . . . it can't ever rust and has much more resistance to corrosion.



Killark ELECTRIC MANUFACTURING CO.
Vandeventer and Easton Aves. St. Louis 13, Mo.

QUESTION:

What "priceless extras" will you find in Worthington high speed turbines?

for answer, turn page ——→

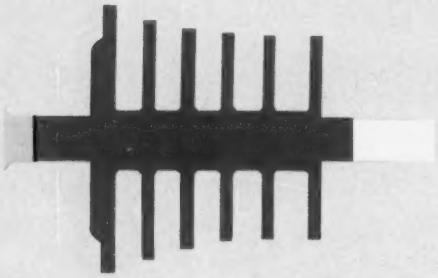
4920 hp, 7000 rpm Worthington turbine driving a centrifugal compressor at Sinclair Refining Co.'s East Chicago, Ind., plant.

ANSWER:

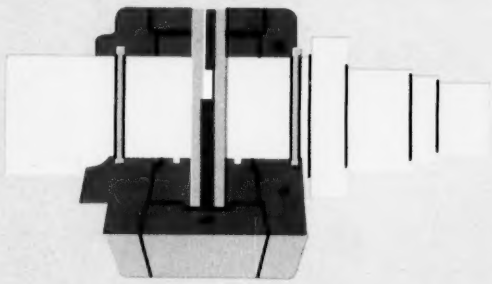
Six quality features . . . key to reliability

Reliability is the ultimate goal of every step that Worthington takes in the design and manufacture of compressor-drive turbines. Worthington reliability is confirmed by 32 years of experience in this specialized field and over 1,257,643 installed horsepower driving all major makes of compressors. When planning your next centrifugal compressor installation, *regardless of compressor manufacture*, be sure to specify a *Worthington* turbine to assure top reliability with flexible, fast and specialized customer services. Worthington Corporation, Wellsville, New York. 48-5

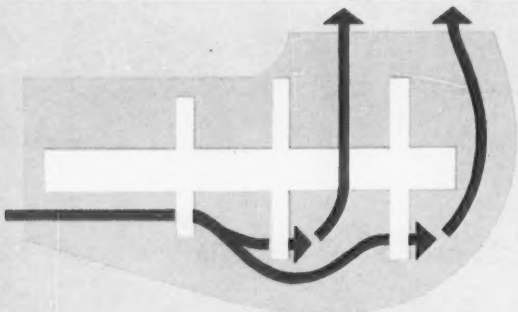
WORTHINGTON



SOLID ROTORS—wheels forged integral with the shaft—provide a more rugged, conservative design.

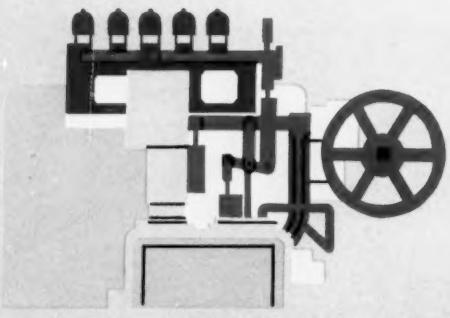


KINGSBURY-TYPE THRUST BEARINGS withstand heavy thrust loads. Shoes pivot, forming a wedge-shaped oil film between thrust collar and bearing surface.

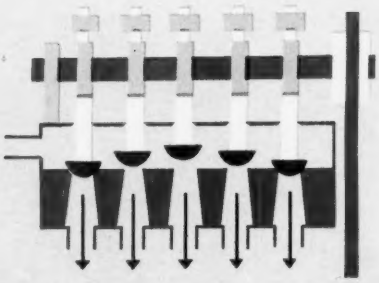


DOUBLE-FLOW EXHAUST—the last stage is divided into two wheels—reduces blade length, increasing efficiency.

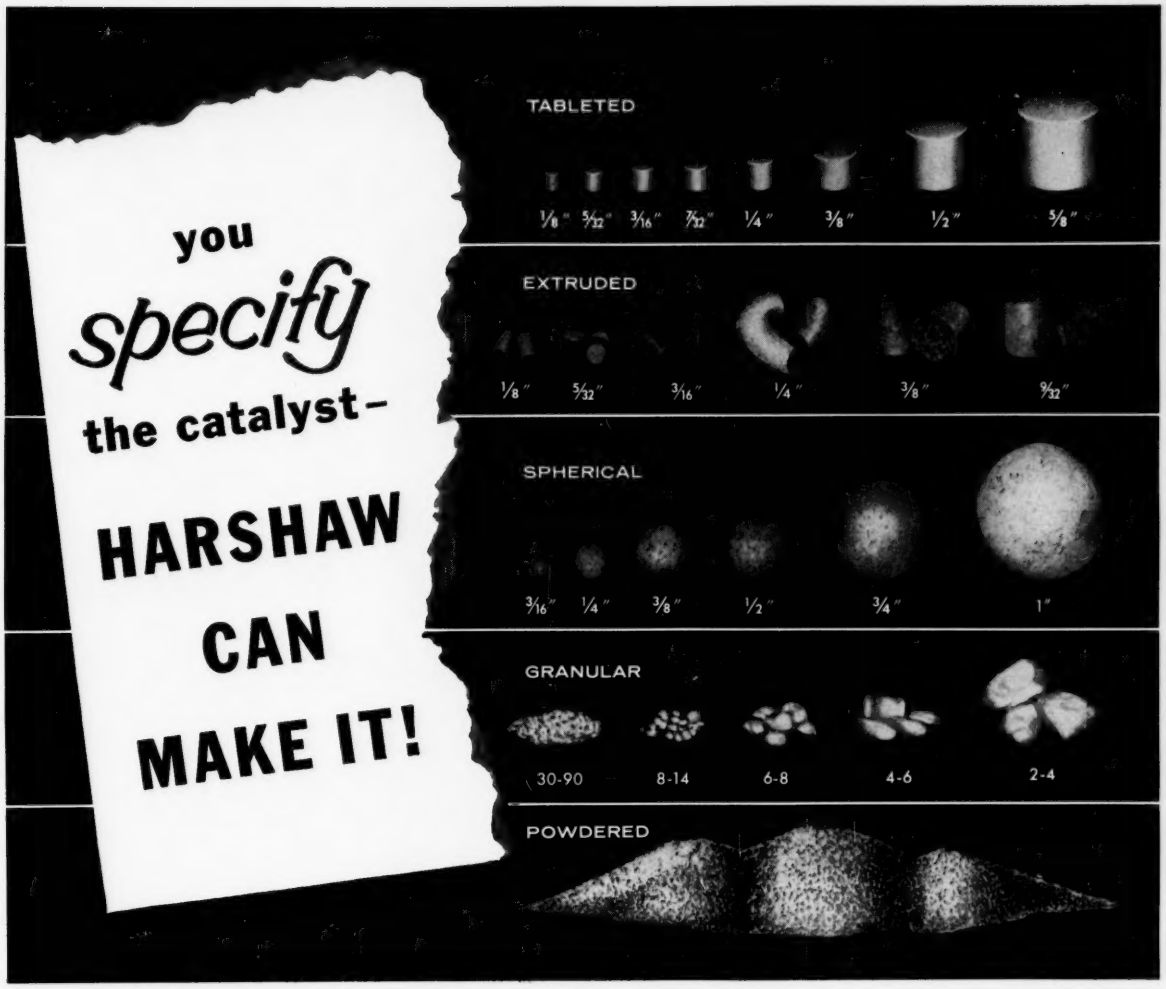
ANTI-OIL-WHIP BEARINGS keep vibration to a minimum. An oil dam in upper half of bearing builds up a pressure pad, keeping rotor firmly in place.



SENSITIVE SPEED GOVERNING SYSTEM provides close control over a wide speed range. (Governor takes air impulses from an outside controller to vary speeds.)



CAM-OPERATED AUTOMATIC NOZZLE CONTROL. Each valve, with separate cam, controls a group of nozzles for maximum economy at all loads.



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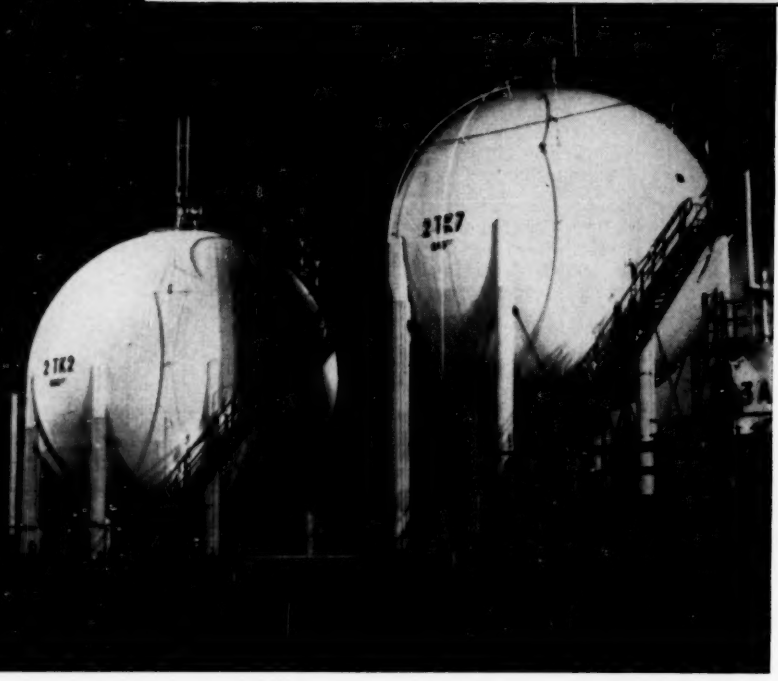
DEVELOPMENTS . . .

PROCESS FLOWSHEET

R. A. LABINE



France's first butyl rubber plant recently came on stream near the city of Le Havre.

Butyl Process Spurs French Economic Boom

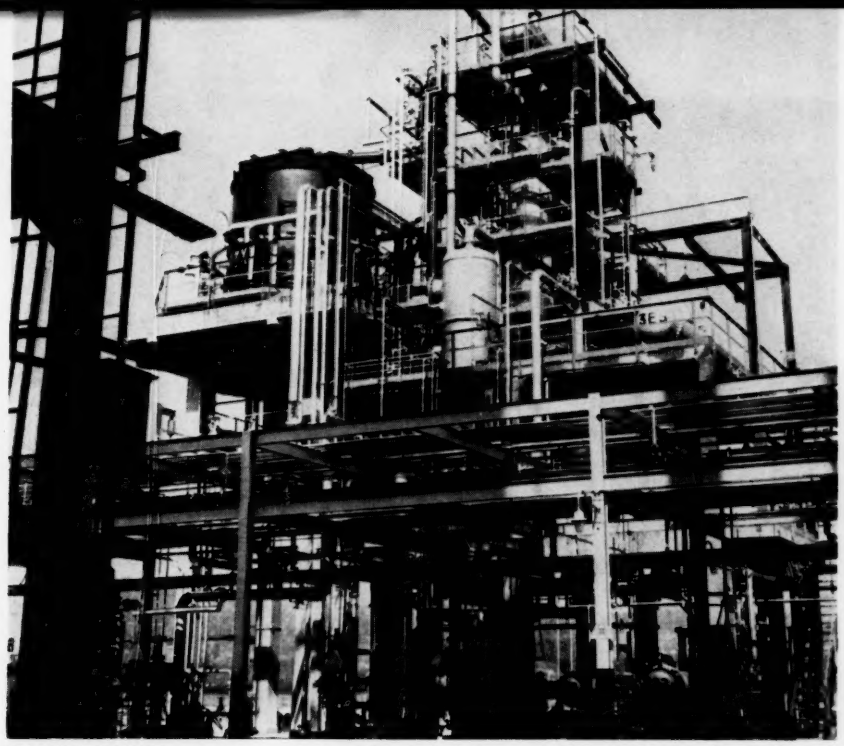
The first butyl rubber ever produced outside North America is now being marketed in France by Societe du Caoutchouc Butyl (Socabu)—formed in 1955 by ten French rubber, petroleum and chemical companies.* Plant's 22,000-tons/yr. output forms an integral part of France's new industrial upsurge—and mirrors the entire booming West European economy. France's rubber consumption in 1961, for example, will be around 25% above the 1956 figure.

Located about 25 mi. from Le Havre, the Socabu plant employs basically the same process used in plants of Esso at Baton Rouge, La., Humble at Baytown, Tex., and Polymer Corp. at Sarnia, Ont. Licensed from Esso Research & Engineering, plant specifications were prepared by C. F. Braun & Co., Alhambra, Calif., and Braun engineers supervised engineering, design and construction.

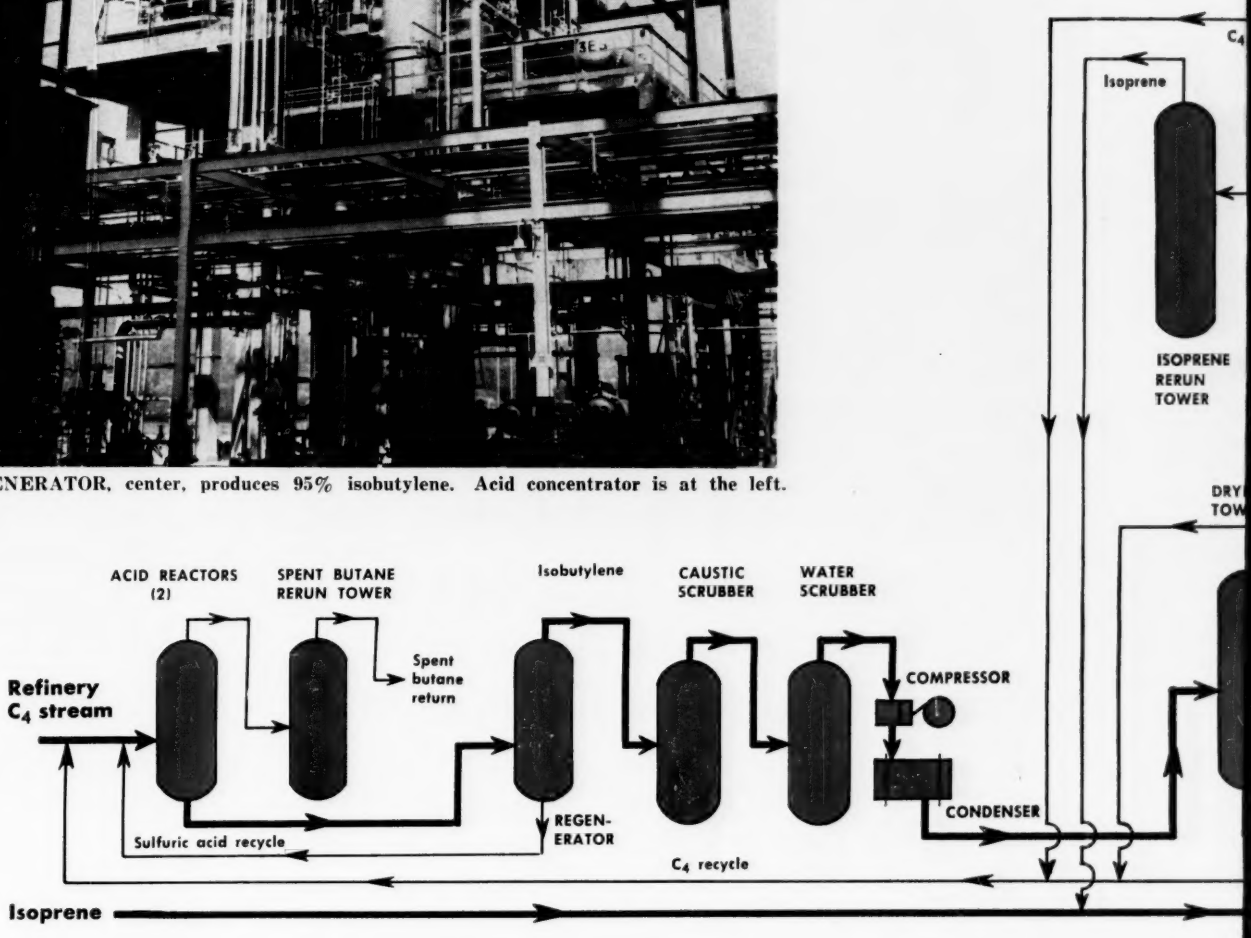
Design philosophy, as explained by Braun's project engineer J. A. Curran, was to stick as closely as possible to the optimum process and mechanical features developed through years of operating experience. "A butyl rubber plant can be designed theoretically perfect, yet without the

* Compagnie Francaise de Raffinage, Esso France, Michelin, Dunlop, Kleber Colombes, Kuhlmann, Rhone-Poulenc, Nobel Bozel, Pechiney and Ugine.

Unfold Flowsheet



REGENERATOR, center, produces 95% isobutylene. Acid concentrator is at the left.



benefit of certain experience factors, the plant will not operate," notes Curran.

The Socabu plant layout consists of an isobutylene extraction unit, a copolymerization unit and a finishing plant. Isobutylene comes from the adjacent Esso-France Port Jerome refinery and from the Gonfreville refinery of Compagnie Francaise de Raffinage. Isoprene is imported from Esso's Baton Rouge, La., plant.

▶ **Isobutylene Extraction**—Feed to the isobutylene unit consists of refinery C_4 fractions and recycle streams from the copolymer unit—making about a 20% isobutylene feed. Unit produces approximately 95% pure isobutylene with about 85% recovery.

Sulfuric acid extracts isobutylene from raw feed in a two-stage countercurrent reactor section. Extract then flows to a regenerator where isobutylene is freed from the acid by dilution and heating. Isobutylene from the regenerator is scrubbed with caustic and water, cooled to remove alcohols, compressed, condensed and sent to storage spheres. Two-stage fractionation then purifies isobutylene to 99%, removing water and reaction poisons.

▶ **Copolymer Plant**—Purified isobutylene mixes with isoprene and is diluted with methyl chloride. This stream feeds to polymerization reactors along with catalyst solution—aluminum chloride dissolved in methyl chloride.

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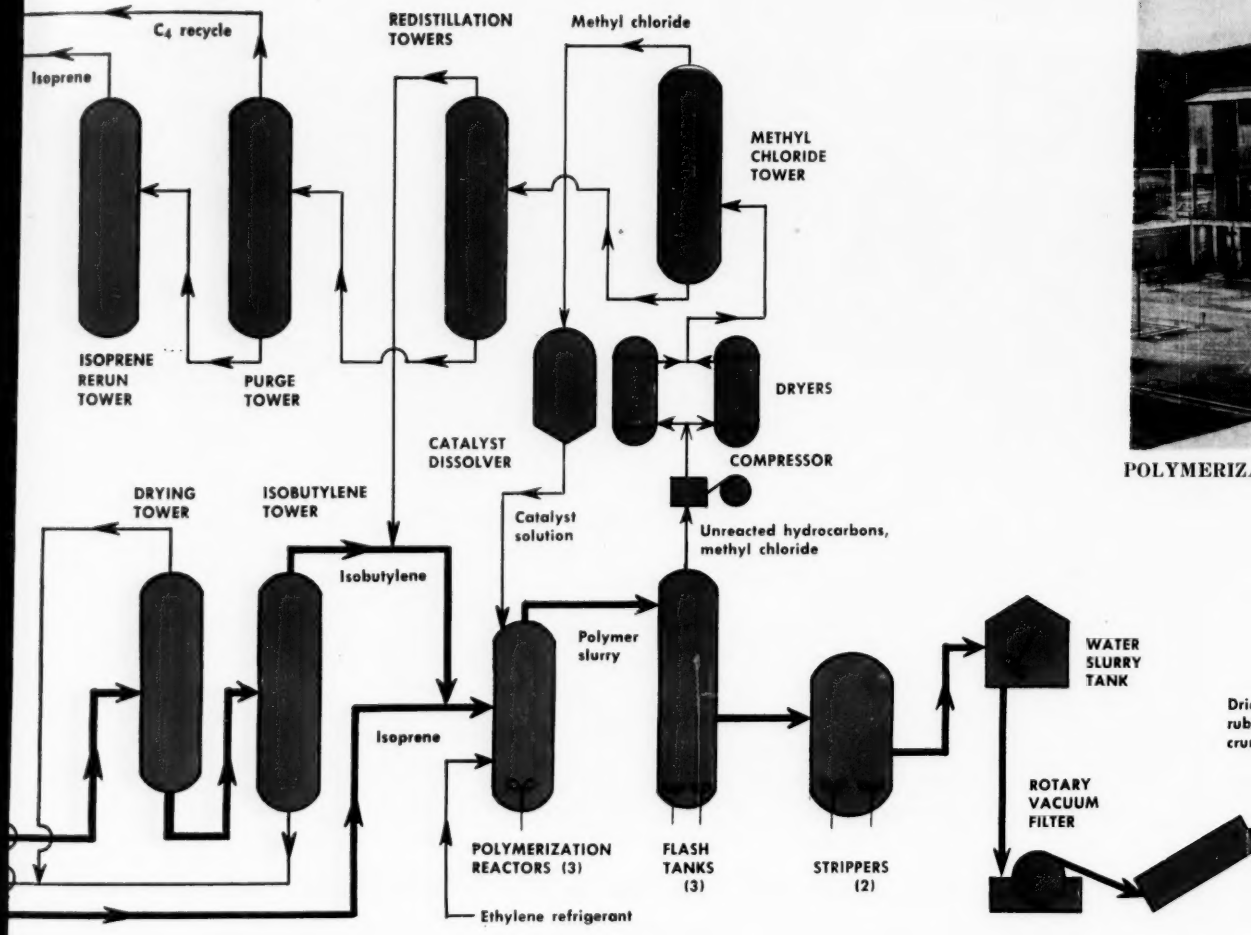


POLYMERIZ

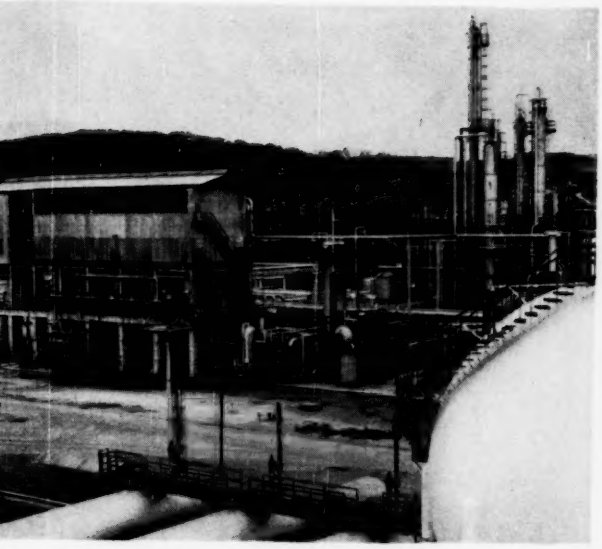
Copolymerization of isobutylene and isoprene occurs exothermically at —140 F. and atmospheric pressure. Reacting mass is violently agitated to assure homogeniety and uniform heat transfer. Copolymer appears as fine white particles that precipitate from reaction mass.

Normally two reactors operate while the third is being cleaned with naphtha on a cyclic schedule. Reactors are 3½% Ni-steel with removable heads for easy maintenance, are refrigerated with liquid ethylene to maintain reaction temperature. Reactor feed is also precooled with liquid propane, then with ethylene.

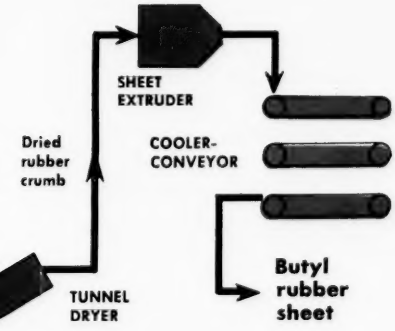
▶ **Following Up**—Reaction mass flows to a flash tank where methyl chloride and unreacted hydrocarbons flash off. Water is added along with a stabilizer to slurry the copolymer particles. Slurry passes through a vacuum-operated stripper where last traces of hydrocarbons and solvents are removed. Slurry, around 3% solids, is pumped to agitated storage tanks in the finishing building.

Methyl chloride, unreacted isobutylene and other flashed-off hydrocarbons are compressed and pass through alumina dryers. Dried gases are again compressed and sent to a fractionation system where high-purity methyl chloride, isoprene and isobutylene are produced.

▶ **Finishing Plant**—Slurry from storage splits into two streams, each going through identical finishing steps.

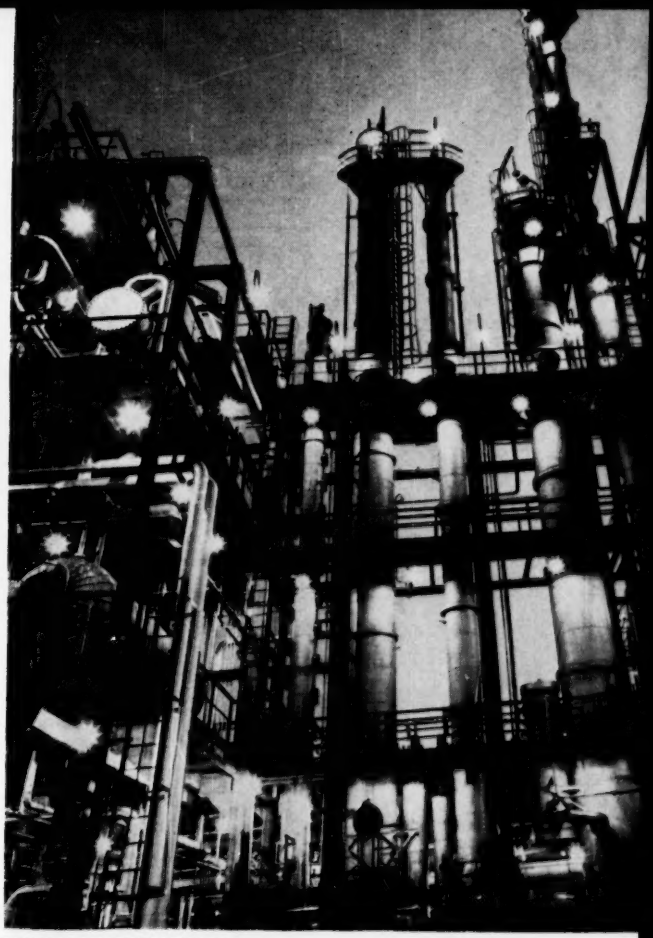


ERIZATION reactors are housed in the building on the left.

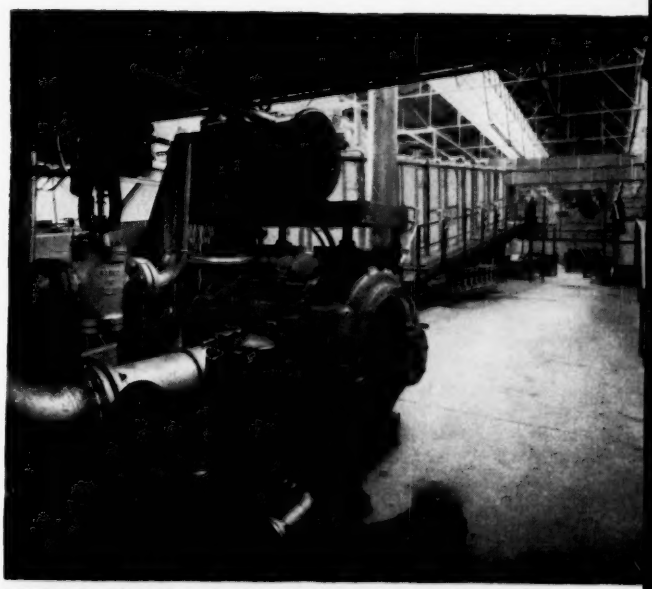


Most of the slurrying water is removed on a rotary vacuum filter. Rubber crumb drops onto a stainless steel pan conveyor that moves slowly through a steam-heated tunnel dryer. Dryer is inclined seven degrees so that crumb drops directly into the extruder feed hopper. In the extruder, last traces of moisture are squeezed out as crumb is agglomerated and forced out in a continuous sheet 14 in. wide and $\frac{3}{8}$ in. thick.

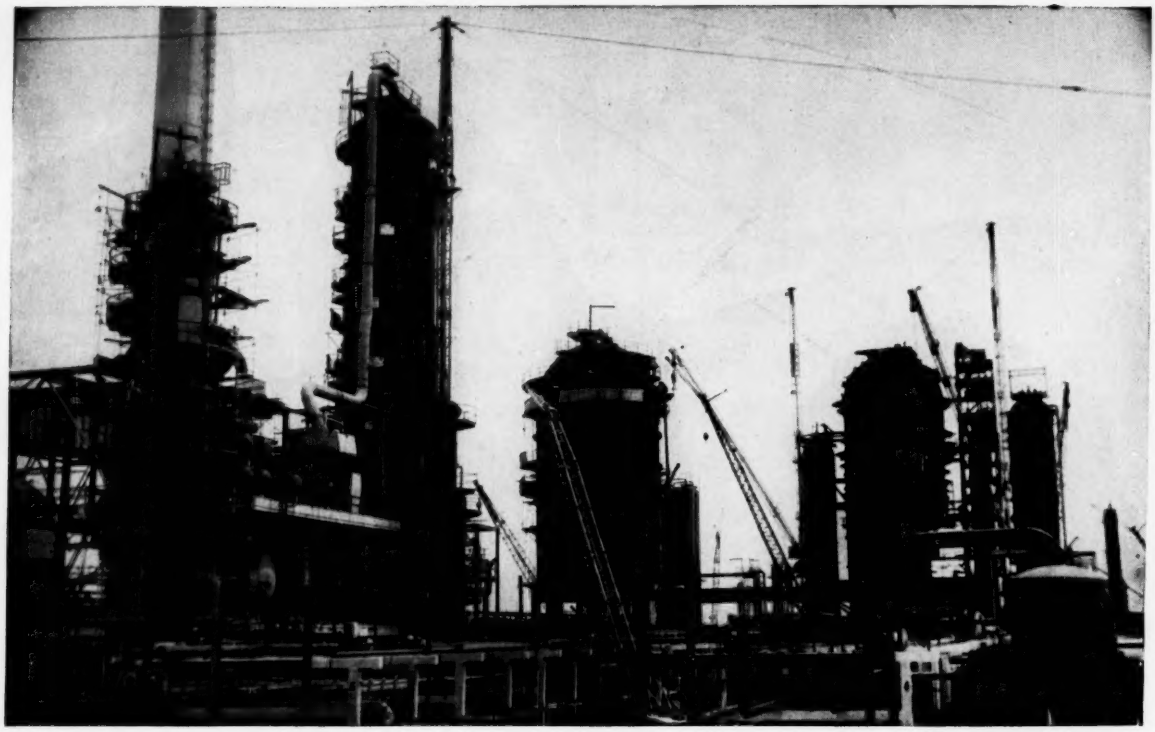
Extruded sheet travels a multi-level conveyor for cooling, then feeds into a cutting and stacking machine. The 14-in. long strips are automatically stacked in 60-lb. bundles, wrapped in polyethylene, and placed on pallets for storage in the warehouse.



PREFRACTIONATION towers concentrate isobutylene.



TUNNEL DRYER in rear. Filter vacuum pump in front.



A dozen vessels built by Newport News were furnished under contract with C. F. Braun, Inc., of Alhambra, Calif., design engineers for the ultra-modern Delaware Flying A Refinery of the Tidewater Oil Company located 15 miles south of Wilmington.

Newport News builds 12 major components for new Flying A 130,000-bpd refinery

This is the Tidewater Delaware Flying A Refinery while under construction near Wilmington.

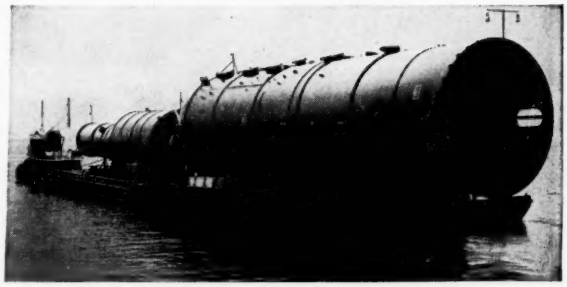
Newport News fabricated 12 of its major vessels — 2 of which are the largest such units ever built: a 250′ Orthoflow fluid "cat cracker" converter and a 225′ reactor scrubber of the fluid coker.

More notable than size, though, is the quality of the Newport News fabrication.

Coke-out screens in the reactor scrubber, for example, are made of 704 12% chromium segments. Welded together with accuracy, they provide 45% clear opening . . . with opening tolerances less than 1%.

You get expert fabrication, the skill of specialists when Newport News builds your equipment. When you want reactors, pressure vessels, vacuum tanks and the like, sub assemblies or weldments in almost any size or shape, get a bid from Newport News.

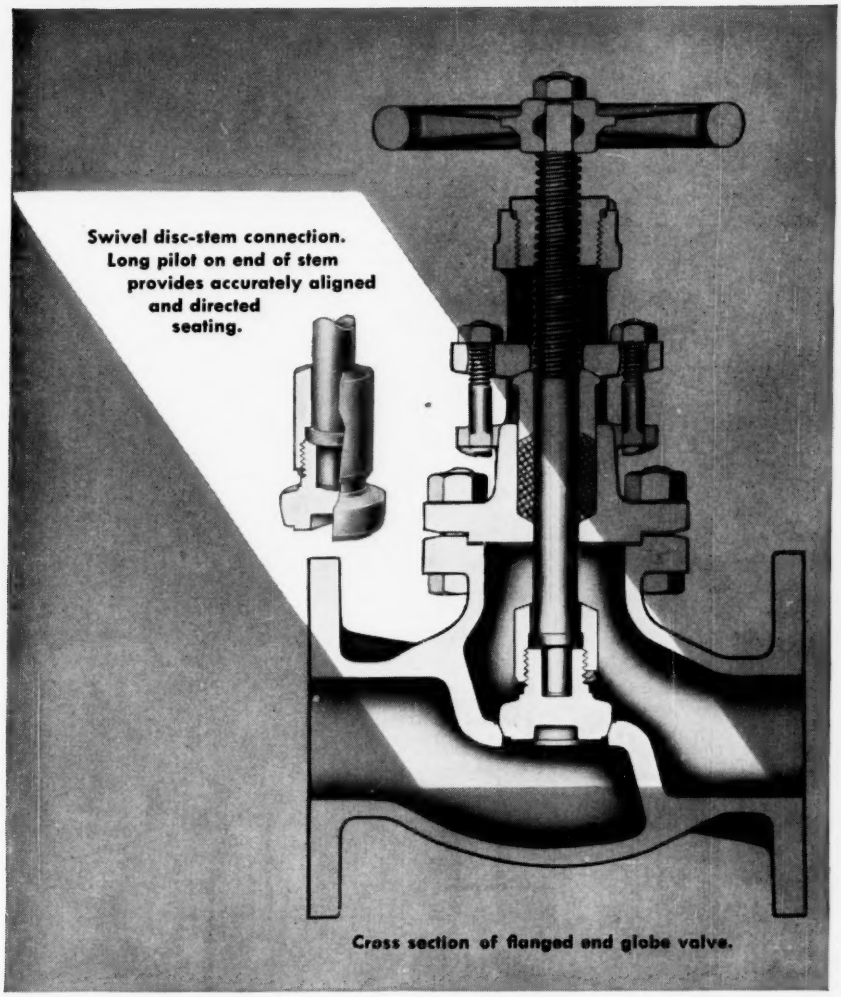
Send for newly published, easy-to-read, illustrated booklet, "Facilities and Products". It describes the many ways in which Newport News can help you with present or future projects. Write for your copy today.



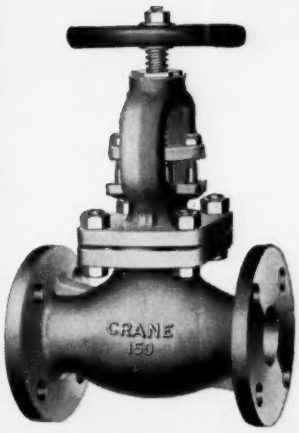
Full advantage was taken of the Newport News deep water loading facilities for transportation of all of the equipment by barge. Shop erection prior to shipment assured fast, trouble-free field assembly.

Engineers: Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

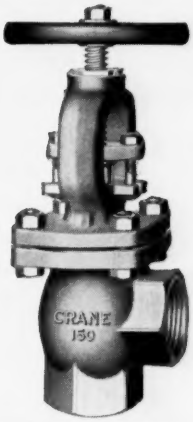
Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia



Cross section of flanged end globe valve.



No. 18811 globe, ½"-6", flanged ends; ½"-2", screwed ends.



No. 18812 angle. ½"-2", screwed ends; ½"- 6", flanged ends.

How this swivel disc saves seating surfaces in Crane 18-8 SMo Globes

Even on toughest corrosive fluids, you will find these valves seating tight long after others have leaked.

The seats last longer because the Crane free swivel disc-stem connection prevents seizing and galling on the seats. The disc stops turning on contact with body seat ring, and the stem takes over all the closing torque.

Minimum clearance in disc-stem assembly prevents vibration and chatter, and the long pilot end of stem guides the disc squarely to seat.

Another feature of this disc—its modified plug type design combines the easier seating of a narrow ball-to-flat seat, and the greater resistance to erosion and scoring of a wide plug type disc. It's the ideal design for throttling

Improved seating is but one of many refinements that make Crane 18-8 SMo globe and angle valves today's outstanding value in original cost as well as in maintenance savings.

For complete specifications and recommendations on applications for these all-stainless steel valves, consult your local Crane Representative . . . or write to address below.

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This deaerator is designed for removal of all minerals and silica from boiler make-up water at the nation's largest ion-exchange processing installation . . . and protected *permanently* against corrosion, contamination and abrasion with Manhattan Rubber Lining! Giant 52,000 gallon capacity is no problem for R/M lining specialists. If a unit can be shipped, it can be handled at a Raybestos-Manhattan rubber lining plant . . . equipment too large to ship is field lined and vulcanized by experienced and supervised crews.

The most modern facilities available today—*plus* experience dating back to the first tank lined in this country—are ready to assure the best possible lining job for your equipment at Raybestos-Manhattan. Manhattan Acid-Proof Rubber Linings are made from thick, multiple calendered sheets of natural or synthetic rubber for utmost protection and durability. Lining expands and contracts with metal under temperature change . . . won't harden or crack. Manhattan Rubber Lining is bonded to metal so securely tests have proved they can't be separated! Resistance to most acids and alkalis is as positive as advanced technology can provide. To make certain your equipment lining is flawless *and* permanent . . . every Raybestos-Manhattan Lined Tank is tested under high voltage.

Be sure your costly equipment and solutions get the *complete* protection your investment demands . . . discuss your lining requirements with an R/M representative nearest you.

- **Multiple Calendered Sheets**
- **Permanent Protection Against Corrosion, Contamination**
- **Permanent Rubber-to-Metal Bond**
- **Resistant to Acids, Alkalis, Abrasion, Temperature**
- **Largest Facilities . . . Longest Experience**
- **Rubber Lining Plants at Passaic, N.J., North Charleston, S.C.**

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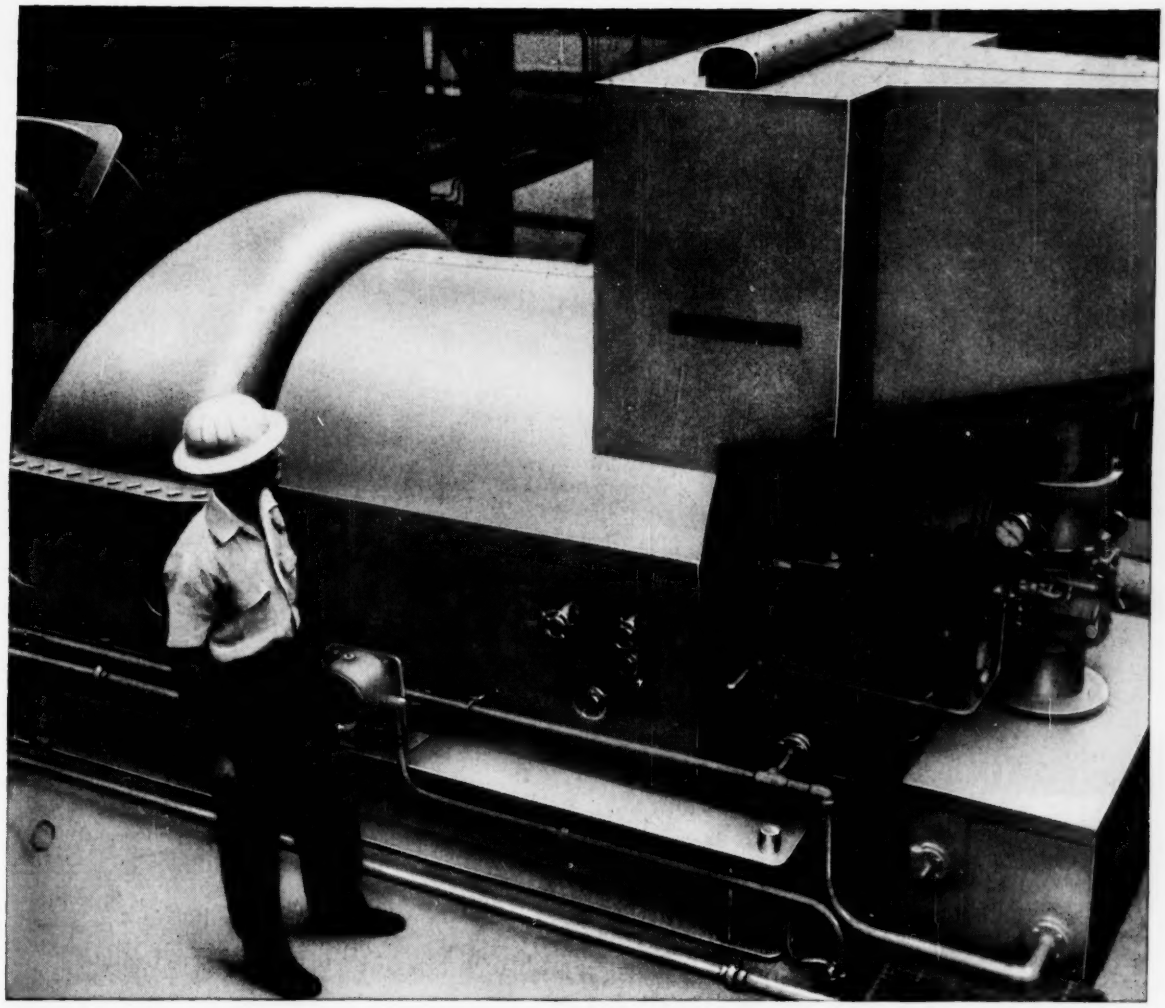

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			As Required		
Wheel Size, in.	12½	16	20	25	32
Maximum hp	4000	5000	7000	10,000	16,000
Maximum rpm	16,000	12,500	10,000	8000	6000
Maximum P_1, psig	1500	1500	1500	1500	1500
Maximum T_1, °FIT	950	950	950	950	950
Maximum P_3, psig	300	300	300	300	50
Exhaust Size, in.	20	24	30	36	48
D. F. Exh. Size, in.	30	36	48	42 x 64½	48 x 84
Max. Inlet Size, in.	5	6	8	10	12

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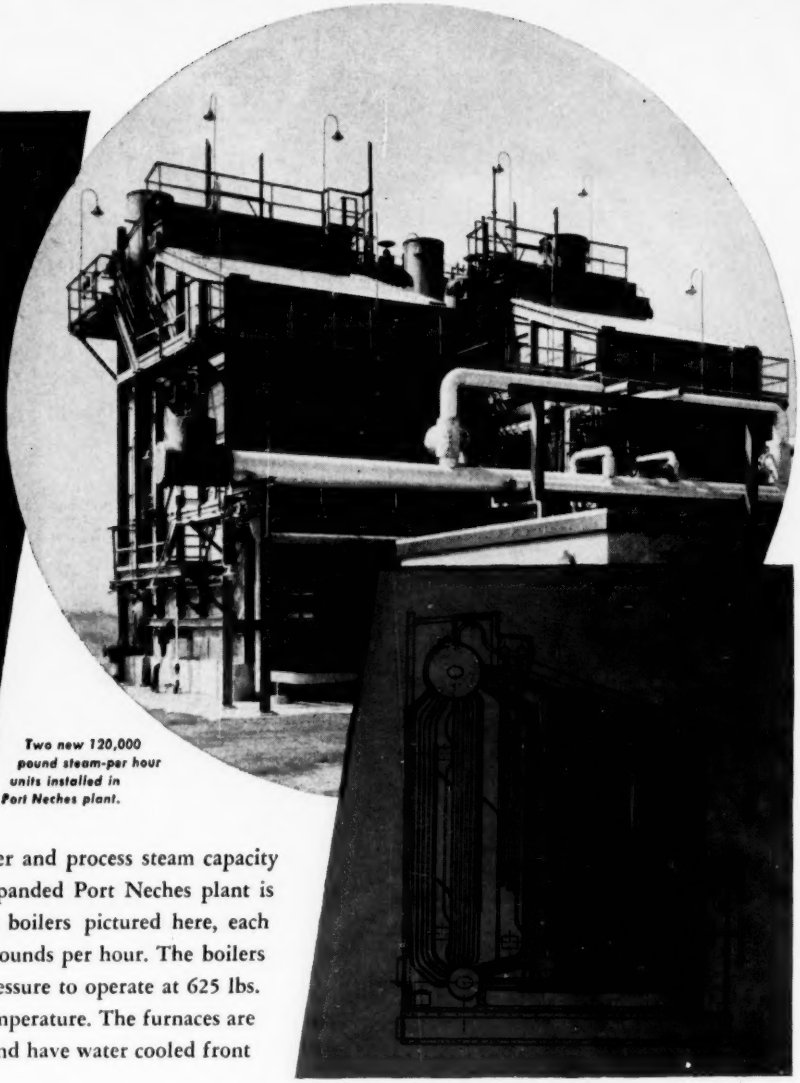

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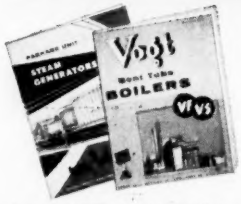

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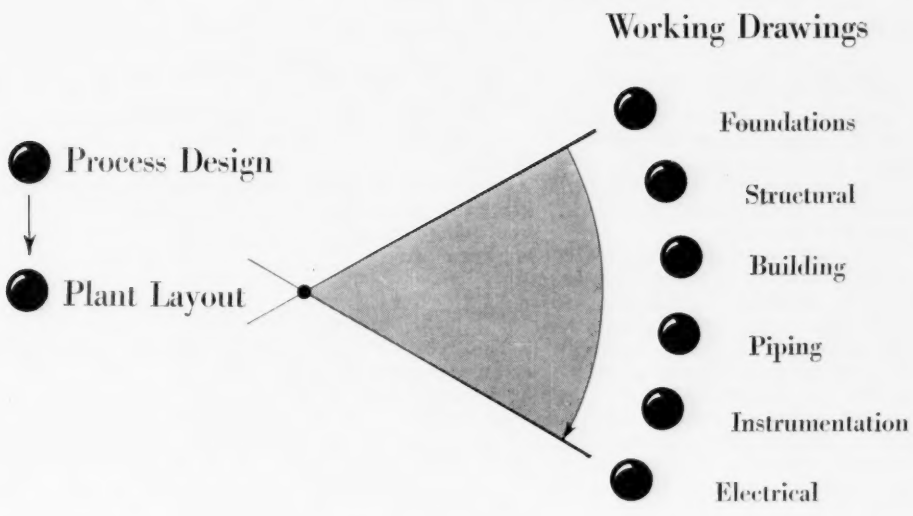


A Rational Method of Layout

From Process to Plant

Here is a step-by-step procedure that makes plant layout functional, orderly and certain.

DONALD THOMPSON, Engineer and Architect, Darien, Conn.

ESTABLISHING a fixed layout early in the program for a new chemical plant can be the single most effective means of insuring economical production of working drawings and prompt completion of construction.

Yet, of all the specialties involved in plant design, the layout of plant and piping is often least systematic.

In this series of two articles we offer a step-by-step procedure that makes plant layout functional, orderly and certain. This first article discusses over-all procedure and philosophy. In an early issue, a second article will cover the actual, practical methods of process plant layout.

A plant layout is not a document from which a plant is built. Rather, it's a pattern; a framework for the myriad empirical dimensions of plant arrangement, all of which must be established before actual construction drawings can proceed effectively. Economy in the production of these

drawings will be proportional to the exactness of the layout, its dependability and its freedom from tampering.

Where a prototype is available as a model, a layout can usually be developed from it by quantitative change. But in the chemical industry, process novelty is usual and it's often necessary to start from fundamentals.

Begin With Process Design

Preliminary studies of layout should begin during the earliest stages of process design. The two are so interrelated that one can benefit from the concurrent development of the other.

Although equipment sizes (and perhaps even types) may not be definite, planning can begin on a qualitative basis, evolving towards the ultimate objective of a fixed dimensional arrangement as information becomes available.

Plant layout is primarily a problem in finding the optimum combination of several factors, some of which often conflict with each other.

In this sense, physical planning—like any other kind of planning—is basically a problem in organization. That is, in organizing relationships among individual parts that together will make up a satisfactorily integrated whole.

Define the Problem

The first step in planning is to define the problem. In terms of process plant layout, this means first to *establish*, and next to *evaluate*, the various factors that together will shape the layout.

Most important single aspect of the planning problem is the evaluation, wherein you weigh carefully the degree of importance of each requirement.

This is where most planning difficulties originate. In the failure first to recognize, and next to appraise accurately and without bias, the many factors influencing the arrangement of the plant.

In Three Dimensions

The ultimate objective of plant layout is to establish locations in three dimensions. These locations are for all physical constructions that together define the shape of the plant and are determined by choice. They include:

- Equipment.
- Structural frames and supports.
- Walls and floors—the surfaces that define building spaces.
- Pipe banks and racks.
- Walkways, stairways and operating aisles.
- Instrument panels and control stations.
- Maintenance and dismantling facilities.
- Roadways and rail sidings.
- Yard drainage and protective fencing.

Complete plant layout will establish all locations, the lack of which would delay the production of working drawings.

Predetermine One Dimension

The vertical relationship of many processing steps is governed by or facilitated by gravity flow. This must be determined at the outset by the process engineer and the most convenient form to record it is right on a flowsheet.

Problems of layout may be reduced to two dimensions (those in plan) if the third (the vertical), governed as it is largely by process requirements, is established beforehand. This is done most easily by a scale flowsheet.

Such a "planning flowsheet" can be developed after the process flowsheet has been established and during the period when equipment sizing calculations are being made. It can evolve into the complete engineering flowsheet by the subsequent addition of instruments and minor piping. By taking the place in this way of most of the effort otherwise spent in preparing the engineering flowsheet, it need add little to the total time spent on the job.

Information necessary to construct such a flowsheet is the outline of equipment and process flow interrelationships. As sizing calculations for fabricated equipment are completed, the results may be presented in sketches defining their shape but omitting skirts, lugs and other methods of support. These will be determined later when their locations are finalized on the layout drawing.

Sizes of ready-made equipment must be estimated at this stage from performance specifications. This is usually not difficult with such items as pumps and centrifuges; but for larger equipment, such as dryers, preliminary information from prospective vendors must be sought.

Don't Overlook Auxiliaries

Don't overlook the auxiliary systems (heating, for example) which are often a part of such units, and don't be misled into underestimating their space requirements.

Outlined below is a procedure showing the steps required in preparing a plant layout "planning flowsheet" and its subsequent development into the complete plant layout. It is phrased in terms of a typical continuous process plant of medium size, but the method applies to projects of any scale, large or small.

Step-by-Step Procedure

1. *Major Equipment First* — Draw each piece of major equipment to scale (¼" or 1/50 metric for the plant of average size; ½" or 1/100 metric for large-throughput units). If equipment sizes are not final, use the best estimate that is available to you.

2. *Add Auxiliaries* — To each piece of major equipment (a distillation column, for example) add related auxiliaries (reboiler, condenser, distillate receiver, etc.) each in its correct vertical relationship to the major vessel. Do not use symbols, but draw each piece in its scale outline.

At this stage show minimum elevation requirements including, for example, the elevation of the base of a distillation column above grade (or bottoms pump).

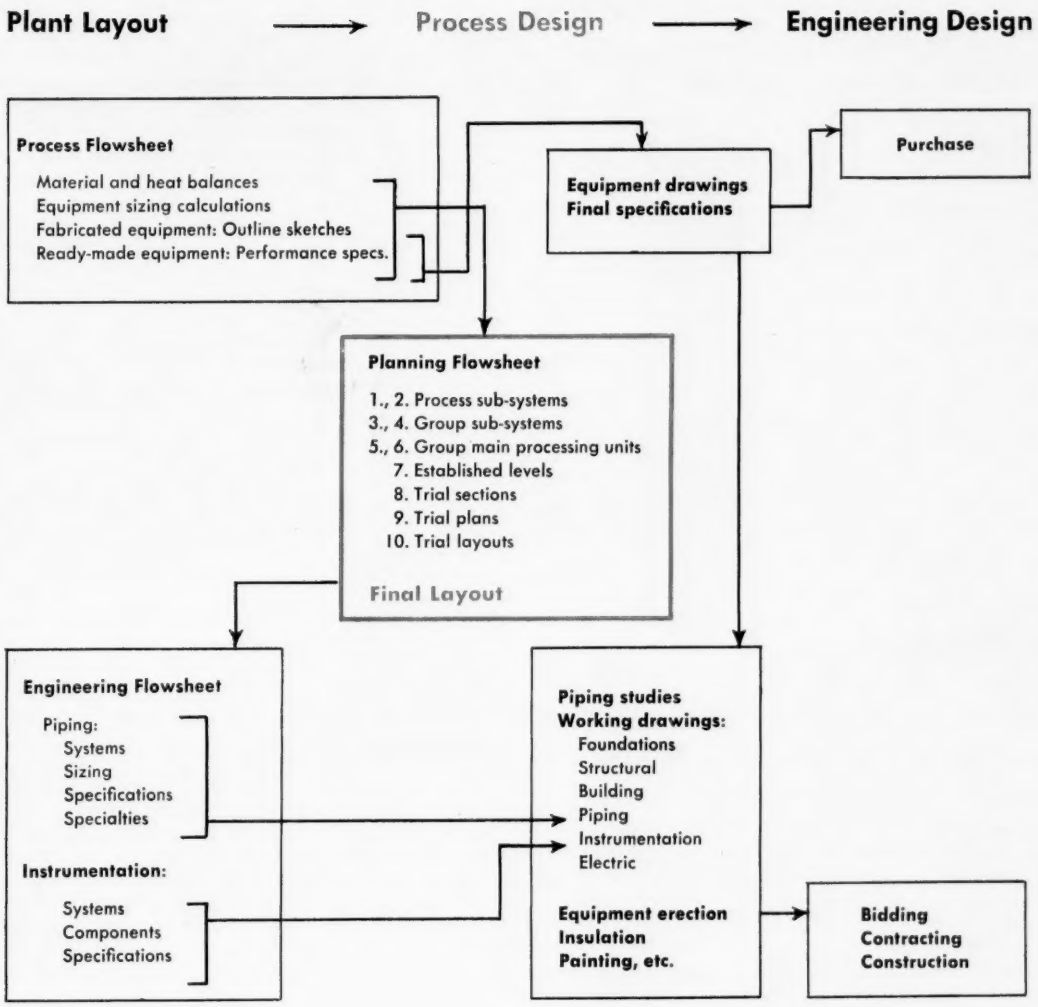
Add pumps (symbols satisfactory) and minor auxiliaries and principal interconnecting pipelines. If piping is large, such as for a vapor-phase reaction system, it will help to avoid being misled by space requirements if such piping is shown on the layout approximately to scale.

Indicate levels for access or operation but otherwise disregard what will later be building or structure levels. See Fig. 1.

Develop each processing step as a unit, which we shall call a "subsystem."

Typical of such sub-systems are the following:

- Reaction systems, including



reactors, reflux condensers, feed and product exchangers, waste-heat auxiliaries, etc.

• Distillation systems including columns, reboilers, condensers, distillate receivers, decanters, overhead and bottoms pumps, feed and bottoms exchangers, etc.

• Centrifuges, with mother and wash liquor tanks, solids chutes, etc.

• Solids-processing systems with inter- and aftercoolers, surge bottles, suction and discharge headers, etc.

3. *Segregate Storage* — Distinguish between working and storage tanks.

Working tanks are related in function directly to major equipment they serve, for example the distillate receivers, decanters and cut tanks on a batch still.

Storage tanks are relatively large-capacity (day to month) units for semifinished and finished materials.

Indicate working tanks on subsystems at minimum required levels (as required by suction head on pumps, for example).

Indicate storage tanks in related groupings in sub-systems separate from the processing systems to which they connect. Because they will probably not be located within

Indicate Vertical Levels for Access or Operation

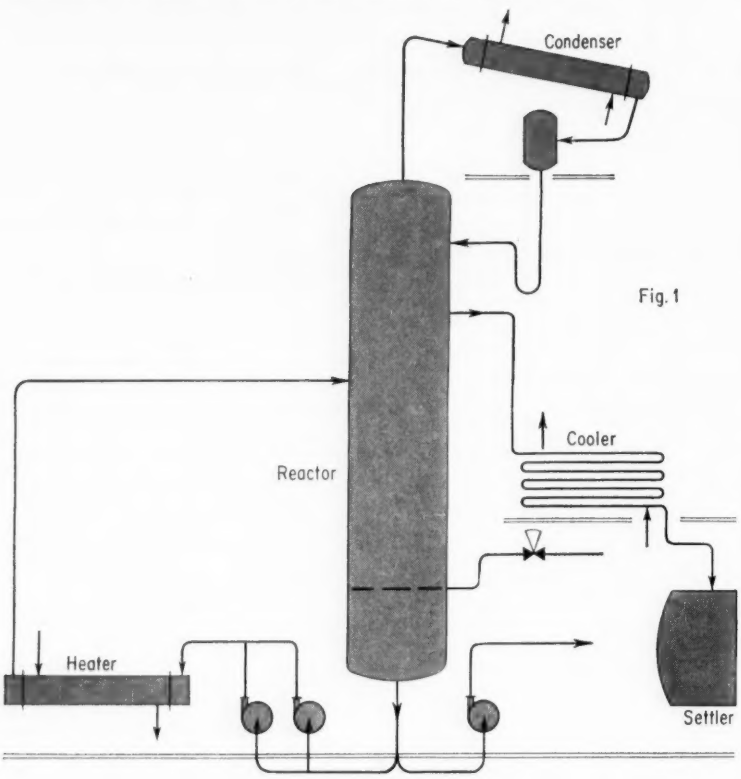


Fig. 1

the processing unit proper (for safety reasons) and because of their large size, you will find it convenient to use a smaller scale (and perhaps to show them in plan rather than in elevation).

4. *Group Related Sub-Systems*—Place sub-systems together in the sequence of the process, excluding storage tanks (unless they are to be located within the processing unit proper).

Note that level indications for platforms, floors and support framing shown on sub-systems do not line up at this stage yet.

5. *Adjust Levels*—Relocate sub-systems in the vertical direction to bring level indications as close to one another as possible. Minimum elevations, of course, cannot be reduced. Tower platforms need not coincide if separate tower platforms are to be used on each of the individual sub-systems.

6. *Group by Main Processing Units*—By this stage, if not before, some feeling will have been expressed about the relative locations of main processing systems. Equipment such as centrifuges and dryers which may justify the protection afforded by a building or a roof or rain shelter, will be recognized as requiring different structural provision than distillation columns, say, on a related solvent recovery system.

At this point the factors suggesting the relationship of main processing areas will begin to emerge. In the drying example referred to above, the solvent recovery system might occupy a separate though adjacent area to the centrifuging and drying system. The individual sub-system flowsheets covering these systems may then be grouped accordingly.

The structure and access levels for these two main systems need not coincide, of course, since they will occupy different areas, with possibly separate structures.

7. *Establish Levels* — The sub-system flowsheets have now been grouped in main processing units; and adjusted vertically to bring structure and building levels as near together as possible.

Tentative levels for building and structure can now be developed. Minimum elevations have already been established on the sub-systems by process considerations. Now, adjust the levels where necessary to bring all levels within one processing unit or area to coincide.

Don't be unduly concerned at this stage with the economics of structure. Simplicity makes for economy and some increase in size is justified to achieve it.

Now, redraw the flowsheets at the new levels and grouped as above in related processing systems. (Redrawing can be done expeditiously by tracing in the new locations.) The redrawn flowsheets can now be expanded into complete engineering flowsheets by the addition of instruments, remaining piping and minor items.

8. *Trial Selections* — Elevations of equipment and structures (one of the three dimension-variables in the planning problem) have now been tentatively established. Now, begin the attack on the other dimension-variables. See Fig. 2.

Develop trial sections of each processing sub-system. Be guided by the factors that affect horizontal relationships (for a discussion of these factors, see Part II of this series). Try for variety, not accuracy of detail. Evaluate the advantages and disadvantages of each scheme as an aid toward developing something better.

9. *Trial Plans*—As trial sections are being produced, begin to think in depth. Think in terms of the

Part II of This Series Will Appear in an Early Issue

Covering specific layout guides for: bay sizes and heights, walls, floors, roofs, doors, windows, access and escape, stairs vs. ladders, safety and maintenance clearances and provision for flexibility.

space relationships in the remaining horizontal dimension, the one at right angles to the plane of the section. See Fig. 3.

Try a plan or two at what we may call the "defining" level, that is, the one that takes maximum space or is most characteristic of that particular processing step. In a distillation system, for example, it may be the second level, the one carrying the distillate receiver with the condenser, perhaps, above it.

In a centrifugation and drying system the defining level may be at the ground, incorporating the dryer which receives the solids from the centrifuge, as well as the wash and mother liquor tanks and their pumps. The space taken up by this equipment will probably be distinctly greater than that required by the centrifuges above.

10. *Trial Layouts* — With both sections and plans developed on a trial basis for each processing system, the building blocks are available out of which the final plant layout may now be assembled.

The interrelationships of processing steps will be governed by factors common to all chemical plant planning, of which the sequence or flow of the process is primary. Modifying this at times—particularly in larger plants—is another common practice of grouping like types of operations together.

This might mean, for example, that two or three individual solvent recovery steps in a synthetic resin plant, say, would be grouped in a separate distillation unit apart from the building in which the resin itself is recovered.

With the combined layout finally put together, the plot on which it will be built now begins to present its own limitations. These may include:

- Location of adjacent plant and interconnections, services and communications.
- Existing roadways, which may define access and blocks.
- Rail sidings, which may govern warehousing and shipping.
- Ignition sources in adjacent areas, which may prescribe clearances within the plot.

Then Begin the Attack on Other Dimension Variables

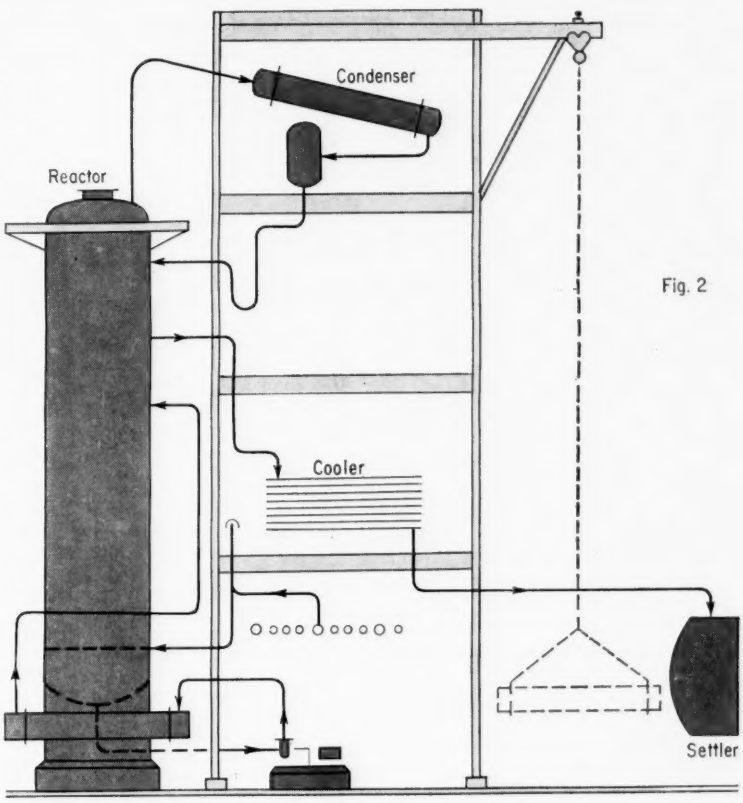


Fig. 2

Think Also in Terms of the Other Horizontal Dimension

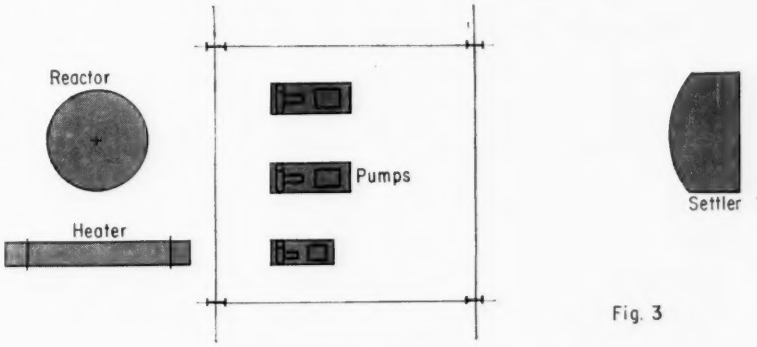


Fig. 3

The Final Layout

Step by step, from small to large, the layout has been evolving into a final arrangement aimed at satisfying maximum requirements. The final layout will become the matrix for working drawings.

With the final layout tested against the evaluation and criticism of all interested parties, it can now become the most dependable starting point for the economical production of working drawings. De-

pendable because a well-developed layout (paralleling a well-developed process design) will insure a minimum of change in working out the details in working drawings.

Preparation of these drawings involves many more people than producing the layout itself. What is a small effort in developing a detail on the layout results in a large effort when this is carried out through the various drawings required for construction.

The planner is at the small end of the lever: What he does will govern the efforts of ten times as many producing working drawings.

Only equipment drawings (which govern, and are not governed by, the layout) are exempt. But even with equipment drawings, peripheral requirements such as skirt heights, support locations, access platforms, etc., are controlled by the layout. The planner is, in a very real sense, the bridge between process design and the drawing program required to execute it; the skilled translator of process requirements into the exact dimensions that build a plant.

A dependable final layout is characterized by a number of factors, all of which are, in the last analysis, *space relationships*:

• Process. Equipment locations are in conformity with requirements.

• Piping. Allocated space and defined locations have been set for main piping banks, valve and control manifolds, instruments and other operating points.

• Structure. There is a uniformity of bay sizes as far as possible and continuity of floors and levels within any one particular structure.

• Buildings. Adequate space has been allowed for wall and floor construction, and for clearances required for doors and windows in the open position.

• Aisles are sufficient for operating and for access; defined and straight, rather than offset; wide, not cramped.

• Access. At least two means of access and escape have been provided for all operating areas and levels except the smallest.

• Stairs are defined in plan and elevation, with adequate space allowed for their construction.

• Clearances between units are sufficient for safety and for major maintenance; within units, clearance is adequate for equipment access and removal.

• Flexibility exists both internally and externally. Internal flexibility permits the addition of an exchanger, receiver or pump which initial operating experience will so often suggest. External flexibility provides space adjacent to the initial plant for future extension in a rational manner.

To convey all of this information accurately, and to avoid misconceptions and errors of interpretation, final layout drawings should be reasonably finished documents, dimensioned as necessary.

Useful Tools for Layout of Chemical Plants

Models and Squares

Layout is a problem in space relationships. As many solutions as combinations are possible and comparison is necessary to determine the best.

Because the human mind is incapable of holding all the elements of several combinations together and comparing one with another, and because others must participate in the comparison, a record of each is necessary. For this, the quickest and most useful means is a sketch, prepared at minimum burden nowadays on squared paper.

Sheets of all sizes are available and for layout studies a ruling of four to the inch is best (one square equals one foot). Freed from the burden of measurement by the built-in grid, freehand sketching with no tools perhaps except ruler and compass, is rapid, facilitating graphic studies. Photocopies are readily available when needed.

The final layout document should be a finished drawing made in the conventional manner permitting normal reproduction, because it will eventually be used by so many others. But its preparation should be resisted until all the various possibilities of arrangement have been thoroughly explored first; and this is done most quickly on squared paper.

Achieving in others a complete three-dimensional understanding of the finished result is done most effectively, however, not by the sketch but by the model. Particularly for planning the piping—that largest of all consumers of time in preparing working drawings—a model is a supreme aid to visualization. And as a promotional device outside the engineering design realm, the model is indeed worthwhile. It has become a very effective sales tool.

But in the search for the ideal space relationship that lies at the heart of the layout problem, the facile sketch rather than the cumbersome model will be found most useful.

Metric Conversion

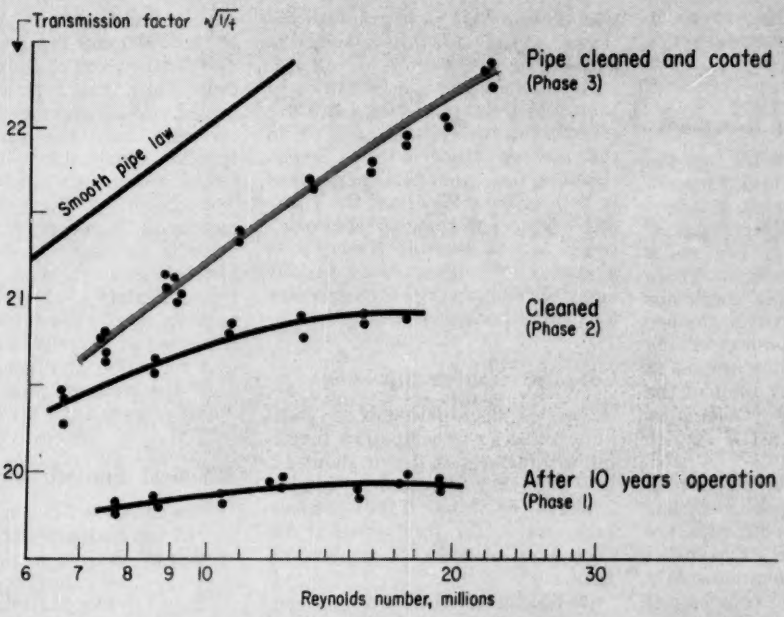
In this shrinking world the planner may one day be working in English units and in metric the next.

The fact that a meter is 39 and an unwieldy decimal in inches need be no burden if for planning purposes he thinks of it instead as an even 40 in.

This approximate conversion makes establishing locations easy in either system. The 20-ft. bay becomes 6 meters, the 4-ft. pump spacing 1.2 meters, and the 6-in. clearance 15 cm.

Meet Your Author

DONALD THOMPSON has been educated both as an engineer (Case Institute of Technology) and as an architect (through apprenticeship to famed modernist Frank Lloyd Wright). Thompson has for over a quarter of a century been designing and building chemical plants. His particular concern has been with what he calls "the mechanical container of the chemical process." He is a member of ASME and a state-registered engineer in New York, Texas and West Virginia.



To Increase Deliverability of Natural Gas . . .

Improve Internal Pipeline Surface

C. H. KLOHN, Tennessee Gas Transmission Co., Houston, Tex.

DELIVERABILITY of natural gas in large diameter pipelines increases 5 to 10% because of interior cleaning and coating. These results were obtained from flow tests made on an 11.896-mi. section of 24-in. O.D. by 0.25-in. wall thickness pipeline near Refugio, Tex. For these tests, flow rates ranged from 150 to 450 million cu. ft./day in increments of 50 million cu. ft./day and at upstream pressures of approximately 700 psia.

This pipeline test section has been in normal and continuous service in the Tennessee Gas Pipeline Co. system for 10 yr. The downstream end is adjacent to accurate gas measurement facilities previously used by the American Gas Assn. After an initial cleaning by one wire-brush type pig, no other cleaning pigs were run through the line during its 10-yr. service.

Only a slight change in elevation exists between the upstream and downstream ends of the line. The pipeline contains 79 wrinkle bends, 81% of which are between four and eight degrees. All of the gas passing through the section has been dehydrated and a large portion has been processed to remove the heavier hydrocarbons.

Data for the project were obtained as follows:

- Phase 1—Test original section after 10-yr. service.
- Phase 2—Clean section with two separately run wire-brush type pigs. Test section after cleaning.
- Phase 3—Use two wire-brush type pigs for cleaning and follow with a 3,000 gal. plug of methyl ethyl ketone as a detergent. Coat interior of line with an epoxy resin. Test section after coating.

A direct result of these tests is that the condition of the internal pipe surface has an appreciable effect upon deliverability of natural gas in large diameter pipe. Results are shown graphically above.

Total increase in the transmission factor, which is directly proportional to deliverability, varies from approximately 5% at a Reynolds

C. H. KLOHN is a member of the engineering department of the Tennessee Gas Pipeline Co., a division of Tennessee Gas Transmission Co. His experience with Tennessee Gas includes assignments in construction, design and operating research. He holds the B.C.E. degree from Rensselaer Poly and is also a registered Professional Engineer.

number of seven million to about 10% at a Reynolds number of 18 million.

Flow Is Function of Roughness

Experiments have shown that the resistance coefficient is a function of Reynolds number when the flow is laminar. As the flow increases, flow laminations are broken and a family of curves develops. These curves of the resistance coefficient are a function of Reynolds number and the relative roughness of the pipe. When laminar flow occurs at the pipe wall, the lower limit of the resistance coefficient-Reynolds number curves represents the smooth pipe law.

As the degree of turbulence increases, the resistance coefficient departs from the smooth pipe law and becomes constant. It is then a function of relative roughness only. This family of constants is termed the rough pipe law.

Nikuradse[4] laid much of the groundwork for present day methods of flow analysis. However, Nikuradse created an artificial roughness of the interior by using uniformly-screened grains of sand and experimented with small pipe diameters and short distances.

Colebrook[5] attempted to describe mathematically the transition from the smooth pipe law to the rough pipe law. Experiments at the U. S. Bureau of Mines[1] have shown that the transition from smooth to rough is much sharper than the Colebrook equation indicates. But again, small pipe diameters and short distances were necessary for the tests.

Using Nikuradse's rough pipe law, engineers of the Tennessee Gas Pipeline Co. calculated the roughness of the pipe after Phase 1 as 912 micro-in. and after Phase 2 as 520 micro-in. Roughness of the pipe after the Phase 3 operation could not be calculated because the transmission factor did not become constant. However, the author estimates roughness after Phase 3 as less than 180 micro-in.

Engineers of the Northern Natural Gas Co. obtained average roughness values after Phase 1 of 952 micro-in., Phase 2 of 573 micro-in. and after Phase 3 of 413 micro-in. These values represent averages of all flow rates for each phase. Actual measurement of the roughness would require many separate measurements to assure representative values. This is impractical because of the excavation and cutting required.

No distinct line can be drawn to break down the increases which are attributable to the cleaning or to the coating since a wire brush cleaning operation was performed in both phases. However, the glass-like surface of some of the epoxy resins is well known. Hence, it is a matter of conjecture as to how many wire-brush pigs are necessary to attain this smoothness.

Consider Smooth Pipe Law

Further examination of the chart indicates a smooth pipe law involving a transmission factor about 4% less than that indicated by the von Karman[2] equation. There are several reasons for this apparent discrepancy. In order of importance, they are:

1. Characteristics of commercial use. The Bureau of Mines work showed that small amounts of liquid or solid material in the pipeline had considerable effect on deliverability. In verifying the von Karman equation for smooth pipe, the Bureau filtered all the gas.

Although the gas used in testing the 24-in. line was dehydrated and a large portion processed by gasoline plants, it is believed that sufficient foreign material was present to affect the transmission factor. Hence, any unfiltered gas stream will produce similar results. Foreign material present in natural gas lines may include substances such as powdered desiccants, compressor lubrication oil, scrubber oils, valve greases and condensate.

2. Another factor contributing to the discrepancy are the 79 wrinkle bends in the test section. These bends add some resistance to flow. One way of correcting this error is to use equivalent length rather than actual length. To obtain agreement between the Phase 3 tests and the von Karman smooth pipe law calls for adding an equivalent length of 63 ft. of pipe for each bend or 23 ft. for each wrinkle. The author believes this is far too much to allow, since the wrinkle is a depression of the interior rather than an intrusion into the interior.

3. Total length of the test section between pressure measurement stations is 62,812.5 ft. Of this length, 147.7 ft. was not cleaned in Phase 2 nor coated in Phase 3. Operations were started 65.9 ft. downstream of the upstream tap and completed 81.8 ft. upstream of the downstream tap. Thus, the test section presented two different surfaces to the stream. Since the sum of these lengths is only 0.23% of the total length, these were not important.

4. Viscosity[3] was calculated not measured. However, a fairly large error is necessary to shift the plot appreciably to right or left.

5. Calculation of the volume of coating used shows an average thickness of six mils. Theoretically, this reduction of diameter will affect the transmission factor by slightly more than 0.1%.

Practical Smooth Pipe Law

The equation for the smooth pipe law of von Karman[2] and the Bureau of Mines[1] is:

$$\frac{1}{\sqrt{f}} = 4 \log [N_{Re} \sqrt{f}] - 0.6 \quad (1)$$

For practical application, the effect of bends and foreign materials may be taken into account by writing a practical smooth pipe law. Using the results of the Refugio tests, a resistance coefficient for Eq. (1) equal to 92% of the actual resistance coefficient can be assumed for extremely smooth pipe in commercial use. Thus a practical smooth pipe law is:

$$\frac{1}{\sqrt{0.92f}} = 4 \log [N_{Re} \sqrt{0.92f}] - 0.6 \quad (2)$$

which reduces to

$$\frac{1}{\sqrt{f}} = 3.84 \log [N_{Re} \sqrt{f}] - 0.64 \quad (3)$$

Note in Eqs. (1), (2) and (3), N_{Re} is Reynolds number and f is resistance coefficient.

In making this investigation possible, eight major natural gas pipeline companies and two pipeline coating companies supplied financial assistance.

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Low Temperature Technology—What's the Latest?

- **In Super Insulation for Storage, Transportation**
- **In Super Refrigeration for Production, Conservation**

WHEN the rare and unusual become commonplace, as the field of cryogenics is rapidly becoming today, the published literature soon becomes, not obsolete, but inadequate.

Extremely low temperatures, below 100 K., are no longer only laboratory curiosities, but are standard operating temperatures in missiles, electronics and petroleum gas liquefaction. Indeed, the processes for the liquefaction, transportation and storage of liquid nitrogen, oxygen and methane, the range between 77 and 112 K., are now old hat—warm, balmy temperatures in comparison with those encountered in handling liquid hydrogen at 20 K. and helium at 4.26 K.

These exceedingly low temperatures—only a few degrees removed from absolute zero—are no longer either rare or unusual. Liquid hydrogen is now used in tonnage quantities in the missile field. Helium, though at present used as a liquid in only small quantities, is being transported and stored in liquid form in ever increasing volume. Future developments, particularly in electronics, will undoubtedly see an increase in the use of helium in liquid form.

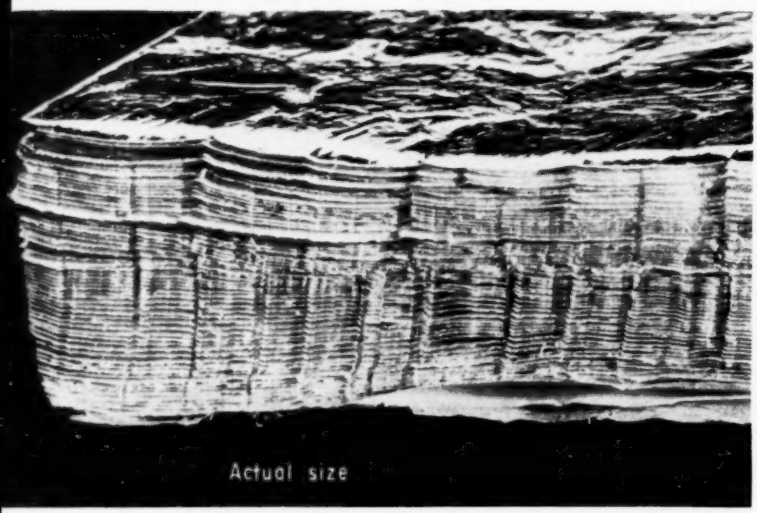
At higher temperatures, liquid methane, at −259 F., is becoming a common article of trade. One company has sent several shiploads of liquid methane from the United States to England, a successful experiment in applied cryogenics.

Handling of cryogenic liquids involves temperature gradients to the environment as great as those to be found in many an industrial plant or process employing heat in the 400 to 500 F. range. As in such applications of "positive" heat, the "negative" heat of very low temperature also requires insulation, but to keep heat out, not in.

Cryogenic fluids are expensive. It costs more to produce a pound of liquid hydrogen than a pound of steam. Further, the properties of cryogenic liquids—low heat capacity, low heat of vaporization—make them relatively sensitive to small increases in heat content. A little bit of heat will vaporize a lot of expensive liquid hydrogen while the same amount of heat removed from steam will condense very little cheap steam. This means that insulations adequate for steam will not do for cryogenic liquids. Super-low temperatures need super-insulations.

Super-insulation was only one of several related subjects discussed this fall at the Cryogenics Engineering Conference. Here, on the campus of the University of California at Berkeley, scientists from all over the U.S. and many other countries presented papers on their specialties — refrigeration, insulation, handling and storage of cryogenic liquids. Our previous up-to-date (at that time) report on low temperature technology (see *Chem. Eng.*, pp. 123-138 Feb. 23, 1959) is now, not obsolete, but inadequate. In this article we will present some of the latest information garnered from papers presented at the Conference. Perhaps this article and our previous report together will be adequate, at least for a little while.

LOW TEMPERATURE . . .



Super Insulation . . . allows shipment and storage of liquid helium in

Super insulation, maximum efficiency insulation, super Dewars, multiple-layer insulation, all of these terms denote the development of insulating systems where the heat transfer mechanisms of gas conduction, solid to solid conduction and radiation have been reduced to a minimum. Although these insulations have been developed only recently, the methods used to reduce heat flow are not new. James Dewar showed in 1898 that an evacuated space between two vessels, suitably silvered, formed an effective barrier to radiant heat transfer. Smoluchowski, in 1910, showed that thermal insulators better than air could be made from fine powders in a moderate vacuum. The work of these men, and others, forms the basis for further developments in cryogenic insulations.

In 1951, Peter Peterson of the University of Lund, Sweden, found that successive radiation shields of thin polished aluminum foil, spirally wound with very thin glasswool spacers, showed remarkable insulating qualities. His test report did not arouse any notable interest because cheaper powder insulation seemed quite adequate at the time. Space age needs for maximum use of available volume and weight in missiles and in transportation facilities for cryogenic liquids have given new impetus to the search for cryogenic insulations of highest efficiency.

The governing mechanisms of heat transfer through insulation are (1) radiation, (2) conduction through gas permeating the insulation and (3) conduction through solid. Maximum efficiency insulation will result when all three contributing factors of heat transfer are reduced to a minimum say I. A. Black, A. A. Fowle and P. E. Glaser of Arthur D. Little, Inc.

The best insulations in commercial use at present minimize heat transfer through residual gas by evacuation; addition of finely divided metal powders reduces radiation in powder insulations. Conduction through the solid is then the dominant heat transfer mechanism.

Application of the Stefan-Boltzman (radiation), Knudsen (residual gas conduction), and Fourier (heat conduction through solids) equations shows that:

Radiation is directly proportional to the emmissivity of the surfaces and inversely proportional to the number of shielding surfaces between boundaries where shielding surface or radiation shield is defined as an isothermal surface of low emmissivity having no direct contact with adjoining surfaces.

Conduction through residual gas becomes proportional to pressure.

Solid conduction is proportional to thermal conductivity and area of contact between components.

The most efficient insulation is produced by the greatest number of radiation shields of lowest emissivity, mounted in series and separated from each other and the boundaries by spacers of lowest thermal conductivities and minimum area of contact under a high vacuum.

A number of arrangements can be used to reconcile theoretical requirements with technically feasible applications. Gold in thin foils gives the lowest emissivity. Silver foils tarnish during assembly of the insulation. Highly reflective aluminum foils seem to offer the most practical solution since they are readily available in foil thicknesses of sufficient stiffness and strength. R. H. Kropschot, J. E. Schrodt, M. M. Fulk and B. J. Hunter of the National Bureau of Standards say that metal coated low vapor pressure plastics, such as Mylar, can also be used to make radiation shields. However, the ADL people say it is difficult to obtain a well coated Mylar sheet; internal strain of the thin coating film causes the film to exhibit greater emissivities than aluminum foil.

Laminar Insulations

Since it is not usually feasible to freely suspend the radiation shield,

tonnage quantities.

some material must be used to separate the layers of the shield. Choice of a suitable spacer material presents the greatest difficulty. The ideal compromise insulation would use spacer materials providing point contacts at largest possible intervals, the intervals determined by the stiffness of the radiation shields. Expected boundary pressures must be allowed for, since an increase in contact area under pressure will result in increased heat conduction through the spacers. Such a situation would occur under the compressive loads of acceleration or atmospheric pressure.

Workers in the field have tried glass and plastic beads as spacers, but they could find no suitable adhesive to hold the beads in place on the foil. They also tried various nettings of glass, nylon and plastic coated glass fibers. Several commercial insulations based on layers of foil and fiber mats or nettings have been developed. One such described by P. M. Riede and D. I-J. Wang of Linde Co. is a medium quality (by cryogenic standards) insulation consisting of two to twenty layers per in. of 3-micron diameter glass fiber mat separated by aluminum foil. This is a relatively low density (2 lb./cu. ft.), low-cost insulation having a conductivity of 1.1×10^{-4} Btu./(hr.) (sq.ft.) (°F./ft.) Linde Co. produces it, calling it SI-12.

Another, higher grade insulation, also produced by Linde, is SI-4. This insulation consists of 40 to 80 layers per in. of sub-micron glass paper and aluminum foil. It is somewhat heavier than SI-12, 4.7 lb./cu. ft., and more costly, but it has the very low thermal conductivity of 2.5×10^{-5} Btu./(hr.) (sq. ft.) (° F./ft.). Our lead photo shows a sample of the SI-4 insulation.

Linde has filed patent applications covering these types of insulation.

Work now in progress in laminar insulations includes one composed of 40 to 80 layers per in. of a newly developed glass fiber paper and aluminum foil roughly equivalent to Linde SI-4 in weight and performance but costing only half as much. Another development still in the laboratory stage is a light weight (4 lb./cu. ft.) insulation with an indicated thermal conductivity, k, of only 1.5×10^{-5} Btu./(hr.) (sq ft.) (° F./ft.).

Powder Insulations

About eight years ago, the best commercially available insulating systems consisted of powders such as perlite or Santocel in vacuum having an apparent thermal conductivity of about 1×10^{-3} Btu./(hr.) (sq. ft.) (° F./ft.) between —300F. and 70F. Study showed that 70% of the total heat transport through the coarser, heavier powders was due to solid conduction, the remainder being attributable to radiation. There is no way to reduce this intrinsic solid conductivity so powders of this type do not offer much opportunity for further improvement. Opacifying (making opaque to thermal radiation) low conductivity but essentially transparent powders has proved to be the more fruitful approach, according to Riede and Wang.

Tests have been made of many such powders in conjunction with reflective and absorbitive opacifiers. Workers at Linde found specifically prepared mixtures of Santocel A and copper or aluminum flakes to be the most efficient. Fig. 1 shows the typical performance of such mixtures in varying proportions. Approximately equal weights of the metal powder and Santocel A give optimum performance. However, the NBS workers found no significant difference in the opacifying effects of silver, nickel, copper or aluminum powders.

Copper and Santocel is preferable to aluminum and Santocel for most applications because of the large heat of combustion of aluminum. The mixture with aluminum is unacceptable when used in liquid oxygen service because of the danger of fire. Linde Co. has produced for several years a formulation of equal parts by weight of Santocel and copper powder. This is Linde CS-5 with a thermal conductivity of 2.2×10^{-4} Btu./(hr.) (sq. ft.) (° F./ft.).

Metal opacifiers improve the performance of powder insulations largely by reflecting radiant heat. However, their use introduced another problem, the possibility of bridging of the metal particles causing a conductive short-circuit in the insulation. Use of a relatively non-conductive radiation absorbing medium, such as carbon, can reduce the possibility of conductive short-circuits.

Smoluchowski investigated the insulation properties of finely divided carbon powders, but carbon was considered too dangerous a substance to be used with liquid oxygen. However, Black, Fowle and Glaser of ADL reported that tests showed a mixture of carbon and silica particles can be made non-explosive in the presence of liquid oxygen even when it is 70% carbon by weight. Thermal conductivity of a carbon-silica insulation is 1.6 to 4.1×10^{-4} Btu./(hr.) (sq. ft.) (° F./ft.) depending on the silica and carbon used. This low conductivity compares favorably with the copper-Santocel insulation mentioned previously.

The performance of various conventional insulations and the powder and laminar insulations discussed here are compared below.

Opacified powders are four times better than conventional powders while the laminar types are seven times better than the opacified powders, i.e. the laminar types are twenty-eight times better than the conventional powders.

Insulation	Conductivity, K	Density
Santocel "A"	1.2×10^{-3}	6.0
Perlite	0.9×10^{-3}	8.0
Copper-Santocel	0.22×10^{-3}	11.0
Carbon-Silica	$0.16\text{-}0.41 \times 10^{-3}$	....
Laminar (SI-12)	0.11×10^{-3}	2.5
Laminar ((SI-4)	0.025×10^{-3}	4.7

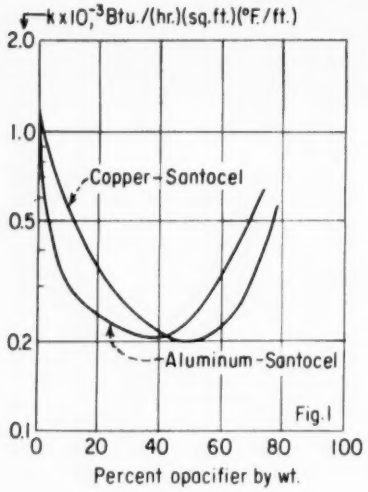
Units: K = Btu./(hr.)(sq.ft.)(°F/ft.). Density = lb/cu.ft.

Fig. 2 gives the thermal performance of two laminar and one powder insulation as a function of absolute pressure in the insulating space.

Note that 1.0 micron (10^{-4} mm.) or better is required for the laminar insulation to ensure best performance while a 10 micron vacuum is tolerable for the powder.

Though powder insulations do not have the very low thermal conductivities of the laminar insulations, all the authors agreed that they do have advantages peculiar to themselves which make them preferable in some situations. Powder insulations are effective at higher absolute pressures, an economic advantage since extremely high vacuums are expensive to produce and maintain.

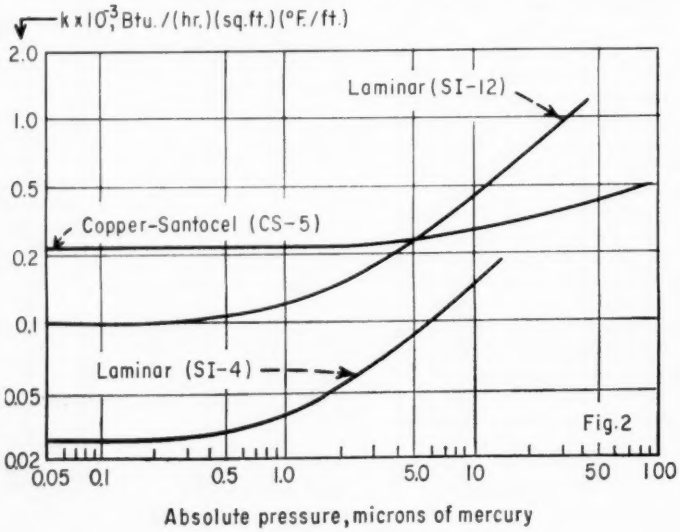
Opacified Powder Performance



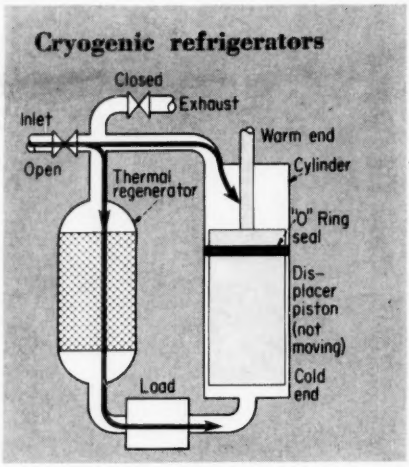
It is no problem to install powder insulation in a vessel with intricate geometry. It costs less than laminar insulation, a significant advantage in large storage vessels. Weight, however, tells against the powder insulations in many applications. Where maximum insulation with minimum weight and bulk is required, there is no present substitute for laminar insulation.

Many companies have expended much effort in recent years on the various practical problems associated with the application of these super insulations. These problems included maintaining a permanent vacuum, applying insulation to geometrically irregular contours, and accommodating structural supports and piping through the insulation. Also, they had to optimize insulation density consistent with mechanical stability under the rather severe conditions of shock and vibration encountered in the handling and transporting of the vessel. Application of these insulations has now become routine. Many vessels have been in satisfactory, maintenance-free service for several years. Redesign of a popular sized 26,000-gal. storage tank using these new insulations now makes it possible to store liquid hydrogen for a year with less than 10% loss. A 15,000 gal. liquid oxygen tank for a rocket was redesigned. Evaporation losses were reduced to 0.5% per day for an increase in weight of only 200 lb.

Performance of Super Insulations as a Function of Vacuum



Cryogenic refrigerators



1st Phase

Inlet valve open, exhaust valve closed, displacer stationary at cold end, gas enters and pressurizes entire system.

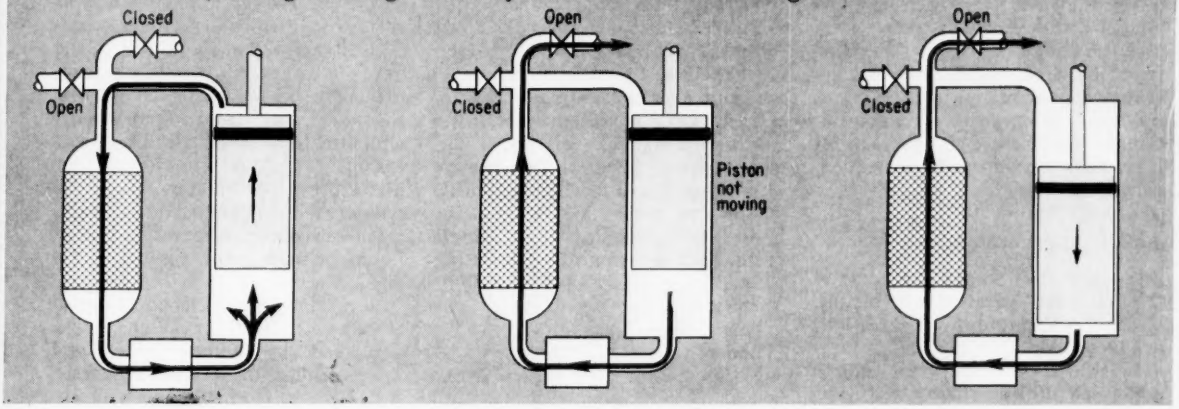
Refrigeration

Insulation is not the only aspect of cryogenics where progress is being made. Much work is being done with new and cheaper methods of low temperature refrigeration.

New electronic devices such as the infrared detector and the maser must operate at extremely low temperatures—20 K. for the IF detector and less than 4.5 K. for the maser. It is not practical, economically or mechanically, to keep these devices cold by constantly bathing them in an evaporating bath of liquid hydrogen or helium. Therefore some means of continuous refrigeration to do the job had to be devised.

Most interesting of the new refrigeration methods is the low temperature gas expansion cycle developed by Arthur D. Little, Inc. This is a new modification of the old adiabatic expansion refrigeration process, the Stirling cycle, which shows considerable promise for a variety of low temperature uses. The refrigerator is a reciprocating expansion device in combination with a thermal regenerator in place of a counter-current heat exchanger. Unlike previous similar systems, the expansion engine valves are at room temperature. The

use closed system gas refrigeration cycle for efficient cooling below 100 K.



2nd Phase

Inlet valve still open, exhaust closed, displacer moves to warm end, forces gas through regenerator to cold end.

3rd Phase

Exhaust gradually opened, inlet closed, displacer stationary at warm end. Gas expands and cools heat load or regenerator.

4th Phase

Exhaust, inlet valves as before, displacer moves to cold end, expelling the residual cold gas. Exhaust closes, cycle repeats.

Systems . . . the key to successful commercial cryogenic applications.

device uses a conventional source of compressed gas, cylinder or compressor.

A unique feature of the system is that no mechanical work is delivered to the exterior. Enthalpy is rejected in the form of heat which gives rise to the interesting phenomenon of a higher gas exhaust temperature than inlet temperature with very low temperature refrigeration in between.

Operation of the refrigerator is shown above. The refrigerator proper consists of a thin wall stainless steel cylinder into which is fitted a displacer in the form of a fairly close fitting piston. The piston can move a limited distance lengthwise. The variable volumes at the two ends of the cylinder are connected through the thermal regenerator. Since the regenerator has very little resistance to gas flow, there is no appreciable difference in pressure between the two ends of the cylinder. Thus no mechanical work is involved in the movement of the displacer.

The inlet and exhaust valves are controlled by cams. The cams are driven by the same shaft that drives the displacer piston.

Operation of the refrigerator is quite simple, say W. E. Gifford and H. O. McMahon of ADL. Compressed gas is supplied from a conventional compressor or cylinder. At zero time the intake valve opens permitting the gas to enter the warm space above the displacer and pressurizing the thermal regenerator. While the pressure is rising, adiabatic compression heats the charge above the displacer; the displacer is not moving. The gas compressed into the regenerator does not heat up because of the large heat capacity of the regenerator matrix (many disks of fine wire screening) and the small gas volume. When pressure equilibrium is reached, the displacer moves from the cold to the warm end of the cylinder. The intake valve remains open. Gas at the warm end of the cylinder is displaced to the cold end through the regenerator and is cooled with consequent decrease in volume. Since the intake valve is still open, more high pressure warm gas enters the apparatus, maintaining constant pressure throughout. When the displacer reaches the top of its stroke, all the gas is at the cold end, the intake valve closes and the pressure is nearly equal to the supply pressure.

During the next part of the cycle, the displacer is motionless while the exhaust valve is slowly opened. It is important that the exhaust valve open gradually because uncontrolled expansion of the gases would result in excessively high flow rates and reduced heat transfer. During this part of the cycle, the gas at the cold end of the cylinder expands. The resulting refrigeration is transferred either to a heat load or to the regenerator matrix, depending upon whether or not a steady state has been established.

Moving the displacer from the warm to the cold end of the cylinder, thus transferring the residual expanded gas through the regenerator and out the exhaust valve, completes the cycle. The exhaust valve then closes and the entire cycle is repeated.

This refrigerator can be built in very small sizes. ADL, has in actual production a unit for cooling IF detectors, called the MinIRcooler, which is only 2 in. long and 0.22 in. in diameter. Using 0.2 SCFM of helium at 300 psi. from a standard cylinder, the refrigerator can main-

tain temperatures as low as 55 K. for many hours. The time required to reach 80 K., starting from room temperature, is about three minutes. Though normally supplied from a cylinder, the unit has operated for as many as fifty hours continuously on gas from a conventional oil-lubricated compressor. It is remarkably insensitive to condensible impurities.

The Cryogenerator

Another new machine, similar to the ADL refrigerator in principle, is the Cryogenerator which is now produced commercially and is marketed in this country by North American Philips (Norelco). According to J. W. L. Kohler of N. V. Philips, The Netherlands, the Cryogenerator is applicable to a wide variety of processes.

The Cryogenerator is similar to the ADL refrigerator in that it employs a displacer and thermal regenerator in the same manner as the ADL unit. It has no valves. It differs from the ADL unit by being completely self-contained, no external source of working fluid is required. It is a closed system gas refrigeration cycle in which the compressor is integral with the refrigerator. A cylinder houses both a compressor piston and a displacer piston both coupled to a single crankshaft by separate connecting rods. The motions of the two pistons alternately compress, transfer and expand the working fluid within the cylinder.

The displacer piston divides the space above the compression cylinders into two sections; the space just below the displacer is the compression chamber while the space above is used for expanding and cooling the working fluid (hydrogen or helium). These two sections are connected by a channel containing three heat exchangers — water cooler, regenerator and condenser.

Motion of the displacer transfers the working medium from the compression chamber to the expansion chamber and back again through the series of heat exchangers.

Operation is quite simple. At the start, the main piston compresses the working fluid to maximum pressure in the compression space. Then the displacer moves the compressed gas to the expansion chamber, the pressure remaining constant. The water cooler removes the heat of compression from the gas as it passes through. The regenerator further cools the gas. In the third phase of the cycle, the piston and displacer move downward simultaneously, expanding the gas. The low temperature thus produced in the condenser head is transferred to the condenser product. Return motion of the displacer drives the cold gas back to the compression space and the cycle is repeated.

Large four-cylinder Cryogenerators now in production can produce 170,000 Btu./hr. of cooling at 77 K. at very high efficiencies. Suggested uses for this machine range from re-condensers for cryogenic storage and transportation vessels to the production of liquid air.

Refrigeration Below 4.2K

Evaporation of He^4 is the usual source of refrigeration at temperatures between 4.2 and 1 K. The helium is evaporated from a thermally isolated bath maintained at the appropriate pressure by a vacuum pump. When the liquid in the bath reaches a certain minimum volume, the experiment must be discontinued, at least temporarily, while the bath is refilled. This process causes excessive liquid loss, not to mention loss of time, since the system must be pumped down again, with consequent evaporative loss of liquid helium, every time it is refilled.

A refrigeration method designed to reduce these inconveniences was described by James Nicol and Henry Bohm of Arthur D. Little, Inc. It is quite simple and will produce continuous refrigeration at these very low temperatures for as long as the supply of liquid helium holds out.

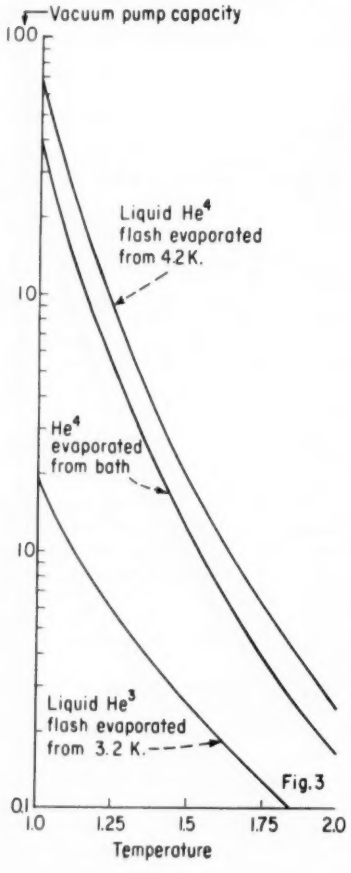
Flash evaporation of any liquid causes cooling, helium is no exception. Nicol and Bohm added an expansion valve to the thermally isolated bath and then fed liquid helium through it. Flash evaporation of the helium at the low pressure prevailing inside the apparatus provides refrigeration at any desired temperature below 4.2 K, though pump size appears to make 1.5 K. the lower limit with He^4.

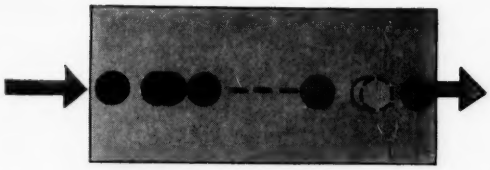
If equipment size and weight are important, if temperatures below 1.5 K. are desired, if high refrigeration capacity is wanted, then the more expensive He^3 may be used in place of He^4. He^3 has a higher vapor pressure than He^4 which means that a smaller pump operating on He^3 can produce more refrigeration at a given temperature and can achieve lower temperatures. See Fig. 3 for a graphical comparison of He^3 and He^4 as refrigerants.

We have not attempted to discuss all the papers presented at the Conference, or even a majority of them. We have, for instance, completely neglected the many excellent papers on storage and handling techniques. However, a previous article (see *Chem. Eng.*, pp. 69-74 Nov. 2, 1959) on safe handling of rocket and missile fuels gave the subject full treatment.

We also neglected papers which dealt with improvements in established methods of refrigeration. Our space allotment has permitted only a brief review of advances in insulation and different refrigeration methods.

He^3 and He^4 as Refrigerants



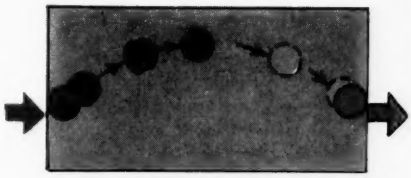


Conduction

Vibration of molecule results in collision with adjacent molecule and transfer of energy.

Radiation

Energy as high frequency electromagnetic wave travels through space until it strikes another surface.



Convection

Molecule receives energy by collision with hotter molecule and circulates to colder surface to transfer energy.

Review Heat Transfer Principles

- What are the mechanisms causing the transmission of heat energy?
- Why does shape factor, series or parallel flow affect conductivity?
- How are equations for the steady or unsteady state resolved?

JESSE COATES and BERNARD S. PRESSBURG, Louisiana State University, Baton Rouge, La.*

WE CAN begin heat transfer by reviewing the elementary concepts of temperature and heat. These quantities are inseparable. According to the second law of thermodynamics, heat will flow spontaneously only from points of high temperature to those of relatively low temperature. Conversely, temperature is an identifying characteristic of matter which is a measure of its ability to transfer heat.

For our purposes, we can visualize any molecule, whether in the fluid or solid state, as being in constant motion. However, in this case the motion is internal. It is vibration, rotation or oscillation of, or within the molecule and need not result in displacement of one molecule relative to another. The higher the temperature of the molecule, the greater is its internal energy. Thus, at higher temperatures, one molecule collides more frequently with a neighboring one. These collisions tend to equalize the terminal energy of the molecules. The faster ones slow down or cool while the slower ones accelerate or become hotter.

When this contact between molecules occurs under conditions that the molecules do not or cannot move from a fixed position such as in a solid, the mechanism of transmitting energy is called conduction. If, after each collision, the molecule is free to move and circulate so that its next collision may exchange energy with a different molecule, the process is designated convection. This occurs in both gaseous and liquid fluids. These are the more significant methods of energy transfer at the temperature levels normally found in the chemical industries.

In some cases, the internal motion of the molecules may result in the emission of electromagnetic waves which may be absorbed by a second molecule. Here, the resulting mechanism of heat exchange is radiation. This mechanism is of major importance in boilers and

* To meet your authors, see *Chem. Eng.*, May 18, 1959, p. 182.

Define Concepts for Fourier Equation

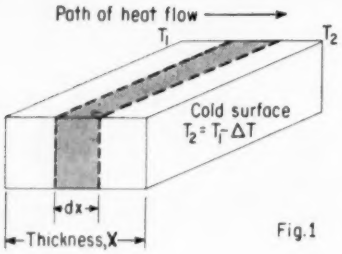


Fig. 1

furnaces, but also occurs at lower temperatures. All three mechanisms of heat transfer are shown in drawing on p. 83.

How Conduction Occurs

We'll start with conduction for several reasons:

1. Because of its widespread occurrence, it has been thoroughly studied and is described more completely and quantitatively than the other mechanisms.

2. An understanding of several of the underlying concepts of conduction will facilitate the handling of convection and to a lesser extent radiation.

For conduction, the basic equation is Fourier's law which is written here in differential form.

$$\frac{dQ}{d\theta} = -kA\frac{dT}{dx} \qquad (1)$$

For definitions and consistent units, see Fig. 1 and nomenclature.

The differential $dQ/d\theta$ is readily identified as the instantaneous rate of thermal energy transport through the body. Differential dT/dx is the potential gradient measured along the path of heat flow, while k and A are physical factors which influence the thermal resistance of the body. As given by Eq. (1), this differential form is a common starting point for all problems, whether steady or unsteady state, regular or irregularly-shaped objects.

In most engineering applications, we are concerned with the steady state where $dQ/d\theta = q =$ constant and with shapes that are readily described mathematically. With these restrictions, we can write Fourier's equation in integrated form:

$$q = k_m A_m \Delta T/X \qquad (2)$$

Analogy to Ohm's law and to our potential-resistance expressions in fluid flow[1] is now apparent and defines the thermal resistance* as $X/k_m A_m$. Working with finite objects, we must recognize that k and A can vary along the path of heat flow and that we must use appropriate average values. The problem of defining mean values does not exist with X and ΔT which are the finite differences between the terminal points as shown in Fig. 1.

Recourse to the differential form permits us to determine the correct mean value to use. If we rearrange Eq. (1), grouping dependent quantities, we have two sets of terms to integrate:

$$-kdt = q\,dx/A \qquad (3)$$

By comparing Eq. (3) with the integrated form, Eq. (2), we can define each mean:

$$-\int kdT = k_m \Delta T \quad \text{or} \quad k_m = -1/\Delta T \int kdt \qquad (4)$$

$$q\int dx/A = qX/A_m \quad \text{or} \quad A_m = X/\int dx/A \qquad (5)$$

What Is Thermal Conductivity?

Thermal conductivity k is a temperature dependent property of matter. Its value is the quantity of heat that would flow through a unit cube under unit temperature difference. Hence, in Eq. (2) A, X and $\Delta T = 1.0$. Its magnitude differs greatly from one type of material to another. We're learning more and more about it and will ultimately be able to predict its value for any material[4] at any condition.

For any one substance, k can be expressed by the equation: $k = a + bT + cT^2 + \ldots$. As shown by Fig. 3, the first two terms are adequate for most engineering materials. For other materials, it is a good approximation over a limited temperature range under consideration. When k varies linearly, integration of Eq. (4) shows that k_m is the value of k at the arithmetic mean temperature.

Shape Factor Affects Conductivity

Mean area for heat transfer A_m depends on the variation of A with position along the path of heat

Shape Influences Heat Transfer Area

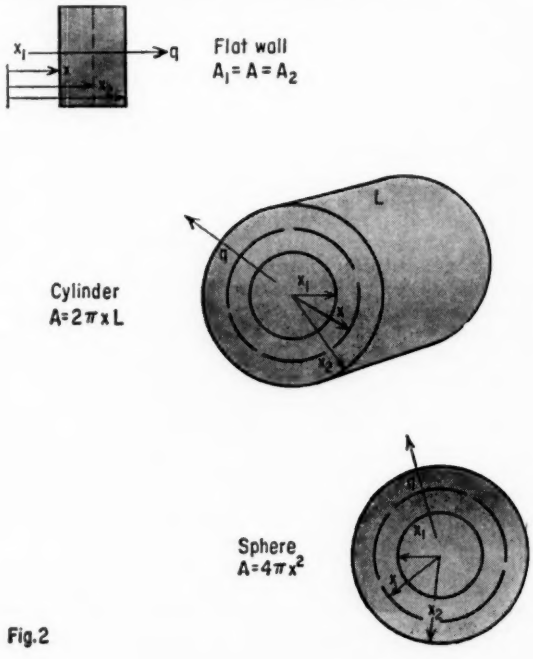
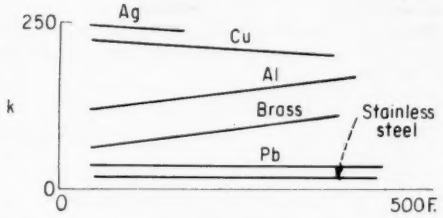


Fig. 2

* Reciprocal of thermal resistance is frequently used and is called the thermal conductance. Note that electrical resistance of a wire or other solid object is given by rL/A. Resistivity r is the reciprocal of the conductivity. Thus the two systems are entirely analogous.

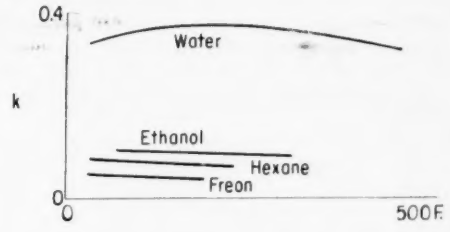
Compare Thermal Conductivities

Fig. 3



Metals

For most pure metals, k decreases with rising temperatures, while for alloys, k increases.



Liquids

Increasing temperature yields decreasing k values for most liquids. Water is exception.

flow from Point 1 to Point 2 as shown in Fig. 2. There are three commonly occurring cases:

1. Area is constant and unvarying with position. This is true in a flat wall. For this case, Eq. (5) shows that $A_m = A_1 = A_2$.

2. Area varies linearly with position. This covers cylinders in which $A = 2\pi Lx$ or cylindrical sections. Substitution in Eq. (5) and integration proves the logarithmic mean to be the correct mean.

$$A_m = \frac{(A_1 - A_2)}{\ln A_1/A_2} = 2\pi L \frac{(x_1 - x_2)}{\ln x_1/x_2} = \pi L \frac{(D_1 - D_2)}{\ln D_1/D_2}$$

3. Area varies as the square of the position along the path of heat flow. For example, $A = 4\pi x^2$ in a sphere. The same treatment shows A_m in this case to be the geometric mean and equal to $(A_1A_2)^{0.5} = 4\pi (x_1 x_2)^{0.5} = \pi (D_1 D_2)^{0.5}$.

Special techniques, mapping or relaxation, are needed for irregularly shaped objects such as rectangular ducts, insulation around certain items of equipment and buried pipe. The following problem illustrates the application of these principles to a regularly shaped, homogeneous object.

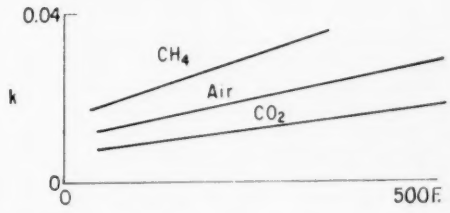
Problem 1—Calculate the heat loss expected from 100 ft. of a 2-in. O.D. pipe that is covered with a 2-in. thickness of 85% magnesia insulation. Temperature conditions are such that the inside surface of the magnesia is at 300 F. and the outside surface at 100 F.

Since heat flow in this problem is steady-state, we can use the integrated form of the Fourier equation, Eq. (2). As indicated in Fig. 3, k for 85% magnesia is substantially linear with temperature. Hence, the correct mean temperature to use is the arithmetic mean or $T_{am} = 200$ F.

The correct A_m is the logarithmic mean because heat is flowing radially and the area varies linearly with position. We calculate this A_m by using the relation given in Case 2 above or $A_m = \pi LD_{lm} = 95$ sq. ft. We now substitute these quantities in Eq. (2) using dimensionally consistent units and find $q = 4{,}100$ Btu./hr.

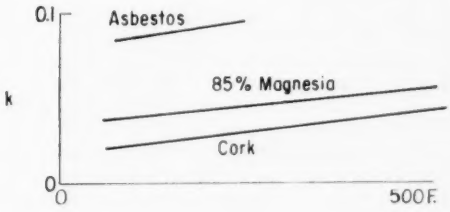
Series or Parallel Heat Flow in Materials

More frequently we must analyze the heat flow through composite bodies. These contain several different materials through which the heat flows in series or in parallel. When this occurs, thermal resistances



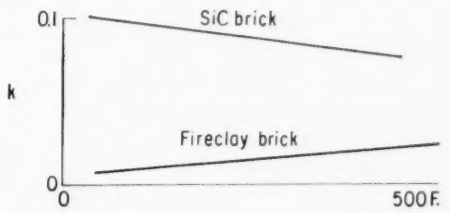
Gases and Vapors

Thermal conductivity of almost all gases and vapors increases with temperature.



Insulations

For most insulating materials, thermal conductivity is proportional to temperature.



Nonmetallic Solids

Thermal conductivity may increase or decrease depending on characteristics of the material.

can be combined exactly the same as electrical or hydraulic resistances.

For series flow, the effective resistance equals the sum of the individual resistances or $q = \Delta T/\Sigma R$.

For parallel flow, the reciprocal of the effective resistance equals the sum of the reciprocals of the individual resistances or $q = \Delta T \Sigma (1/R)$.

In applying these concepts, particularly in the case of series flow, the temperature dependence of k and, consequently, of the thermal resistance makes an analytical solution almost prohibitively complex for anything but a computer. Temperature at the boundary between adjacent materials is unknown and thus the mean conductivity is unknown. To avoid this difficulty, the usual procedure is to assume all interface temperatures; base the thermal resistance on these and then check the interface temperatures by distributing the total temperature potential proportional to the resistances. For example, in series flow:

$$q = \frac{\Delta T_{total}}{\Sigma R} = \frac{\Delta T_1}{(X/kA)_1} = \frac{\Delta T_2}{(X/kA)_2} = \cdots$$

Note that this problem does not occur in parallel flow because $\Delta T_1 = \Delta T_2 = \ldots \Delta T$. Thus, the mean temperature of each substance is fixed and all values of k and R are readily determined.

Problem 2—A flat furnace wall is to be built with a layer of firebrick to withstand the furnace side temperature, a layer of insulating brick to minimize the heat loss and a layer of building brick to protect the insulating brick from the weather or other damage. Characteristics of these bricks are from manufacturer's bulletins.

The furnace side of the firebrick is expected to be at 3,000 F. and the outside of the building brick to be at 100 F. It is proposed to build the wall with 9 in. of firebrick, 13.5 in. of insulating brick and 4.5 in. of building brick.

Calculate the expected heat loss per square foot of this wall and determine the maximum temperature of the building and insulating bricks to assure that these temperatures are within their allowable values.

Since the wall is flat and the heat transfer area for all layers is the same, $q = \Delta T/\Sigma(X/kA)$.

Since the temperature at the junction of the building and insulating bricks and of the insulating and firebricks is unknown, trial-and-error solution is necessary to establish k_m for each material. As a first attempt, assume junction temperature between building and insulating bricks is 500 F. and between insulating and firebrick as 2,400 F.

Hence, for the building brick, T_{am} is 300 F. and k_m is 0.417; insulating brick, T_{am} is 1,450 F. and k_m is 0.246; and for firebrick, T_{am} is 2,700 F. and k_m is 0.979.

Substituting values in equation for series heat flow:

$$\frac{q}{a} = \frac{3{,}000 - 100}{\frac{0.375}{0.417} + \frac{1.125}{0.246} + \frac{0.75}{0.979}} = 463 \text{ Btu./(hr.)(sq.ft.)}$$

Next, calculate temperature drop across the building brick and firebrick and compare to assumed values. For building brick $\Delta T = 463(0.375/0.417) = 415$ F. vs. 400 F. and for firebrick $\Delta T = 463(0.75/0.979) = 355$ F. vs. 600 F.

As a second trial, assume junction temperatures to be 520 F. and 2,650 F. Repeating the calculations, we now find that $q/A = 477$ Btu./(hr.) (sq. ft.). Temperature drop across the building brick is now 429 F. vs. 420 F. assumed, and across the firebrick is 358 F. vs. 350 F. assumed. This check is sufficiently close.

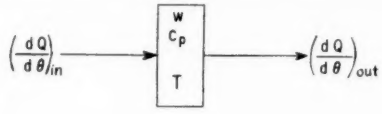
Therefore, maximum temperature to which the building brick is subjected is 529 F. vs. 1,000 F. allowable and for the insulating brick is 2,650 F. vs. 2,500 F. allowable. Hence, more firebrick are needed.

Nomenclature

A	Heat transfer area normal to path of heat flow, sq. ft.
A_m	Mean area long path of heat flow, sq. ft.
c_p	Specific heat, Btu./(lb.) (°F.).
D	Diameter, ft.
k	Thermal conductivity, Btu./(hr.) (sq. ft.) (°F./ft.).
k_m	Thermal conductivity over given temperature range.
L	Pipe length, ft.
Q	Quantity of heat, Btu.
q	Rate of heat transfer, Btu./hr.
R	Thermal resistance $= X/A_m k_m$, (hr.) (°F.)/Btu.
T	Temperature, °F.
w	Weight of material, lb.
x	Position along path of heat transfer, ft.
X	Length of path for heat flow, ft.
ΔT	Temperature difference across material.
θ	Time, hr.

Consider Unsteady State

The unsteady state, as it occurs in batch operations, is governed by the same principles as the steady state. However, these principles require special equations because those given for the steady state apply only to differential time. As indicated in Fig. 4, part of the heat flow accumulates in the body and causes a temperature change. This alters the potential and, to a lesser extent, the resistance of the body.



$$\left(\frac{dQ}{d\theta}\right)_{in} - \left(\frac{dQ}{d\theta}\right)_{out} = w\,c_p\frac{d(T)}{d\theta}$$

Fig. 4

Techniques for solving this basic equation for finite boundary conditions include: (1) analytical solutions,[7] (2) Schmidt graphical method,[8] (3) numerical solutions.[8] Where it is applicable, the first method is the most exact. The other two use finite increments instead of true differentials. While these are not as rigorous, they permit handling of situations to which the first method cannot be applied.

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No. 19: Labor Factors; Instrumentation

William G. Clark, Dow Chemical Co., Pittsburg, Calif.

Compute Labor Needs for Instrumentation

The information in this and several succeeding Cost Files is from a handbook for training engineers in maintenance cost estimating. Use of labor factors makes it possible to apply local wage rates to these tasks. Mr. Clark is an officer of the American Association of Cost Engineers.

Estimate Instruments and Connections

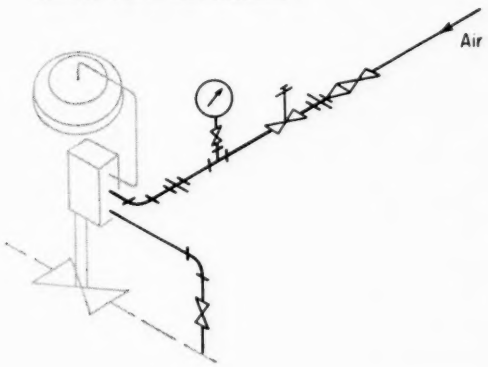
Auxiliaries (shown in detail drawings) are based on steel piping or copper tubing. Labor for these typical connections doesn't include cost of mounting instrument itself or any electrical portions (thermocouple leads, chart drives, rotameter lights, etc.).

Calculate all items installed in piping system (control valves, rotameters, orifice flanges, sight flow glasses, etc.) on basis of a valve of equivalent size. Labor factors for these will be found in article by Mr. Clark: "Accurate Way to Estimate Pipe Costs," *Chemical Engineering*, 243-6, July, 1957. These factors are from same estimating handbook.

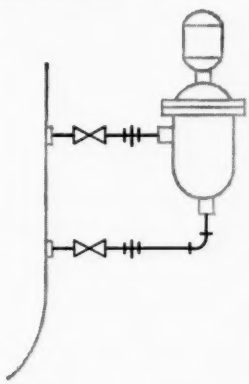
Average Labor for Instrumentation

Panels	
Framework	0.5 man-hr./lin. ft.
Panel (1 ft. wide x 7 ft. high)	2.0 man-hr./lin. ft.
Cut-outs	1.0 man-hr. each
Instrument air supply	
Install valve on existing header and run tubing to instrument	0.5 man-hr. each
Instruments	
Install instrument in panel or mount on field bracket	2.0 man-hr. each
Instrument leads	
Copper tubing between instrument and point of measurement. (Includes main runs only; does not include labor at each end.)	0.22 man-hr./lin ft

Control Valve Man-Hours:6.5 ▼



Liquid Level Control Man-Hours:5.0 ▼



Cost File continues on next page

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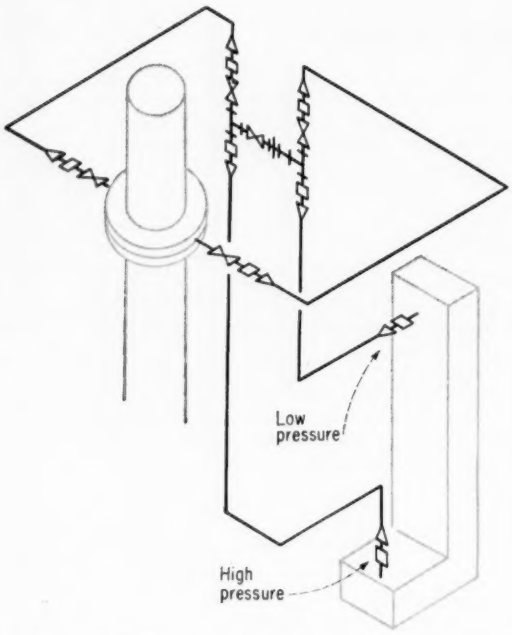
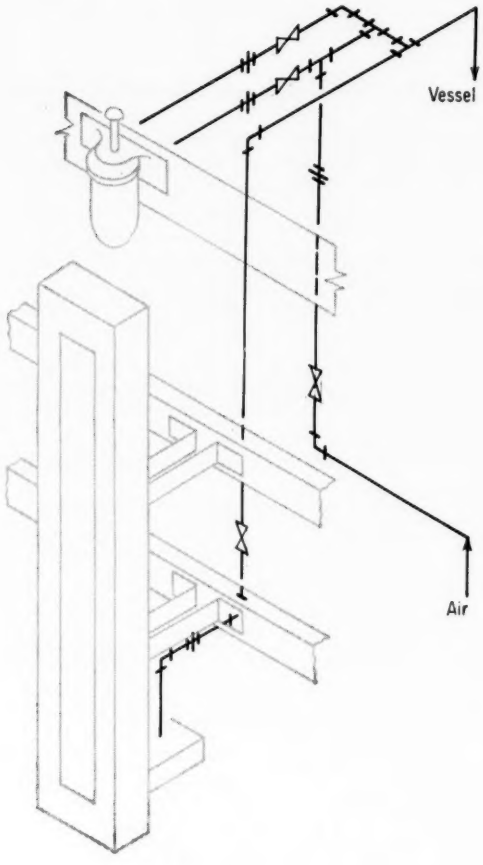
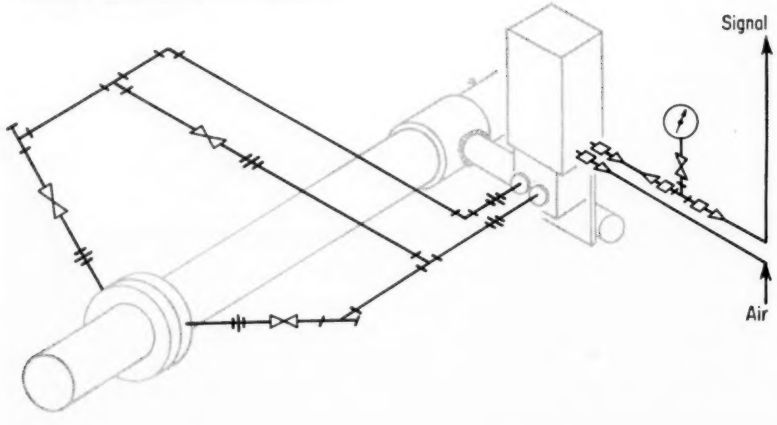


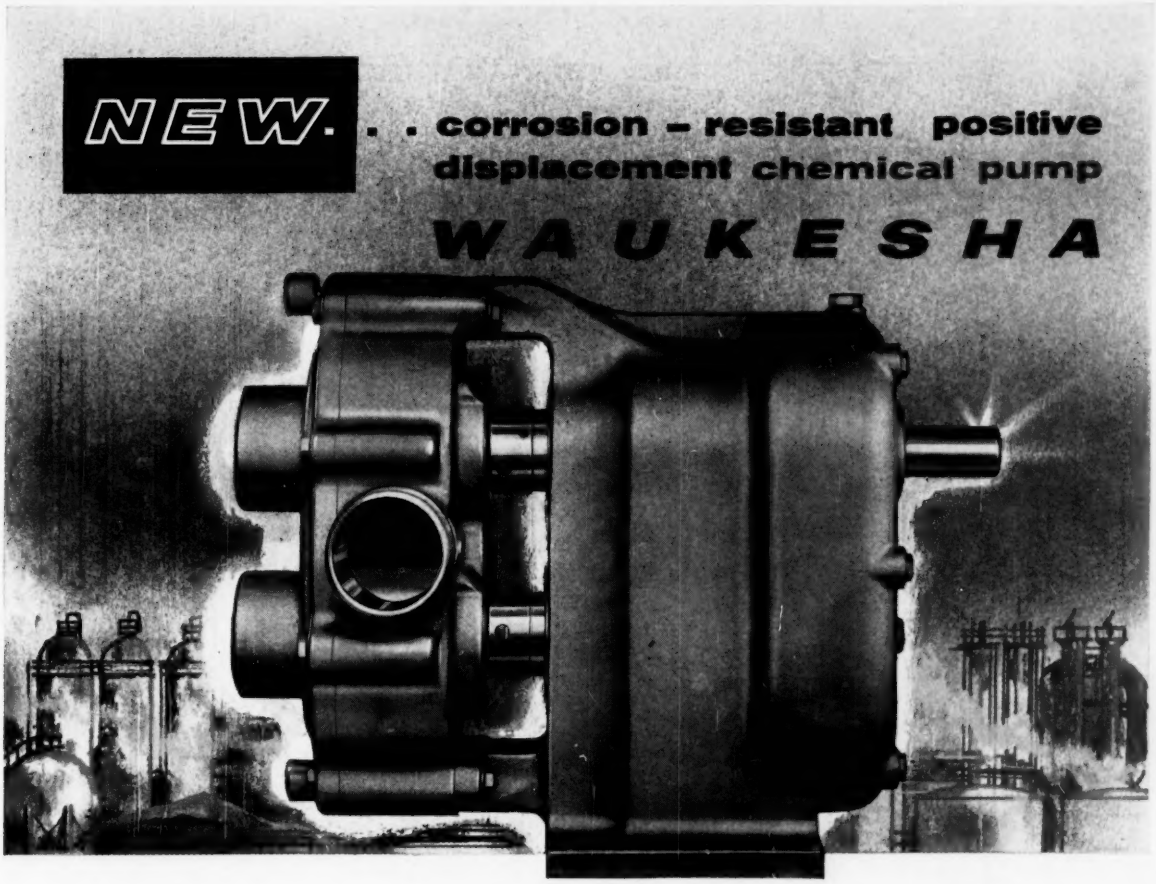
▲ **Orifice Flow Measurement** Man-Hours:4.0



Level Indicator Man-Hours:20.0 ▶

▼ **Pressure Transmitter** Man-Hours:20.0





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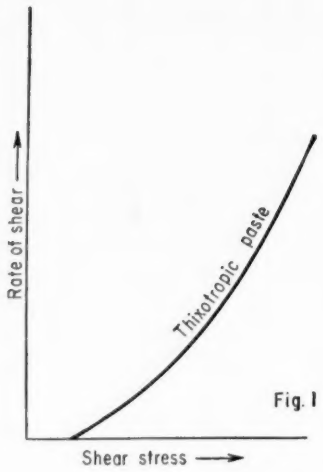


Fig. 1

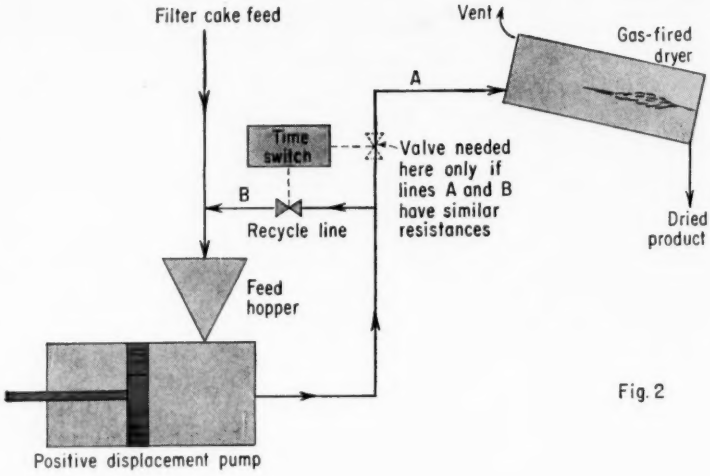


Fig. 2

Timed Recycle Controls Paste Discharge

Mysterious behavior of a thixotropic filter cake handled by a positive pump was solved by recognizing effect of work on its viscous properties.

★ **Winner of the September Contest by**

D. J. Hicks

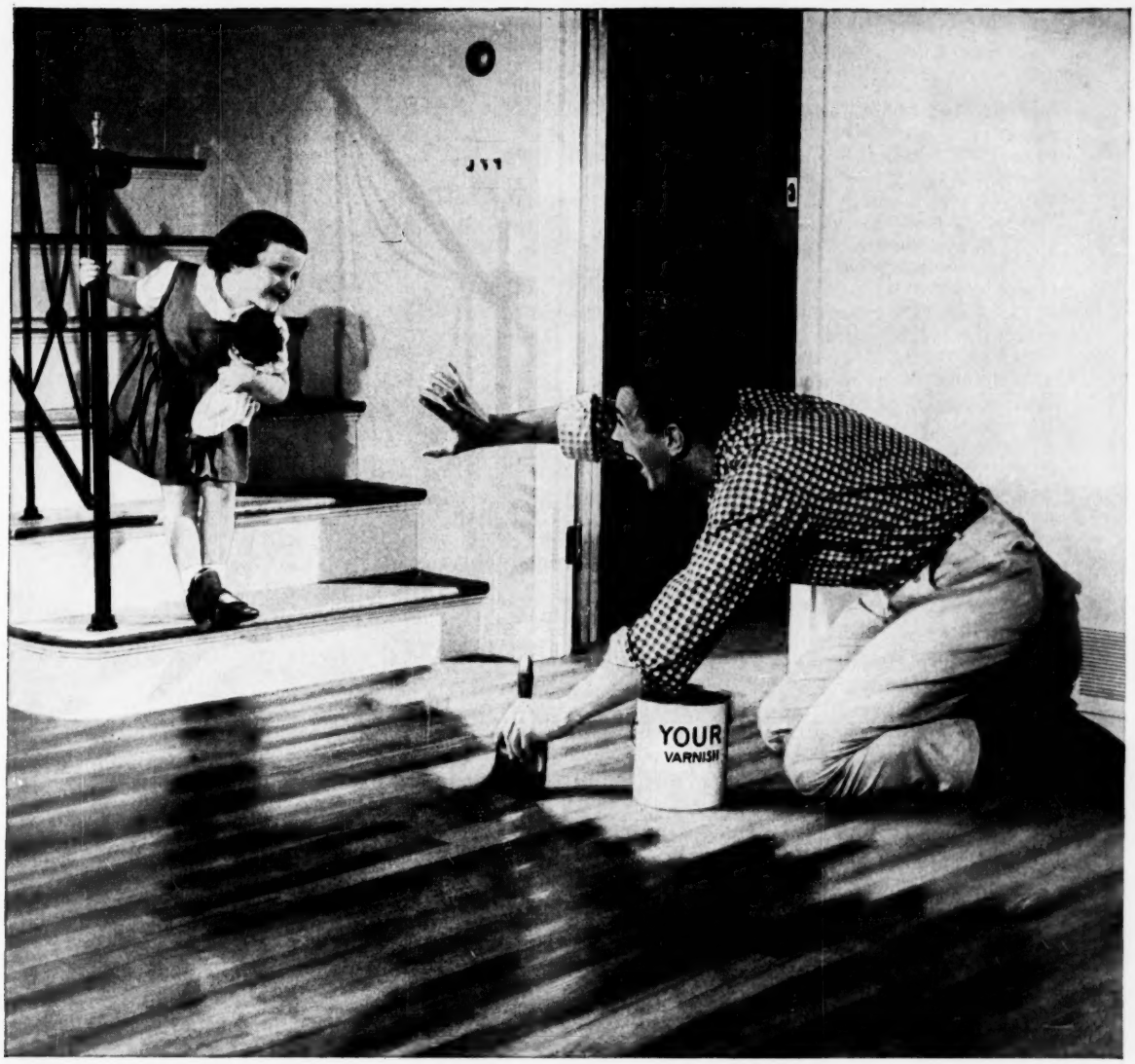
Plant Investigation Dept., Orr's Zinc White Ltd., Widnes, Lancaster, England.

In carrying out some pilot plant work on the pumping of a thixotropic paste, we developed a useful technique which should be equally suitable for plant scale operations. We were trying to pump a filter cake from a previous stage in the process to a dryer, using the only available pump which was of the positive-displacement type, with a constant-speed motor. Our efforts to control the delivery rate by means of a throttled recirculation line were completely unsuccessful.

We were able to get crude delivery adjustments by varying the size of the standard pulleys in the pump drive. We could, of course, have used an infinitely variable speed changer if we had had one, but we did not. Some years back we had seen a description of a method for finer control, making use of a throttled recirculation line, so we tried this, but it proved impossible to keep in balance.

After some thought, the reason for our difficulty became clear. Fig. 1 is a diagram showing how the shear rate in a thixotropic paste is affected by the magnitude of the shear stress which is applied. The structure of the paste breaks down, resulting in a decrease in apparent viscosity, both with time and with increase in the shearing stress. Conversely, although the diagram does not show this, the initial structure can rebuild itself, with apparent viscosity increase, if the externally applied forces are withdrawn.

Applying these ideas to our actual situation, here is what happens: When we have two flow lines (e.g., the line to the dryer and the recirculation line), a minor increase in resistance in one of them will cause a reduction of flow. This in turn will cause an increase in apparent viscosity in that line, which brings about a further increase



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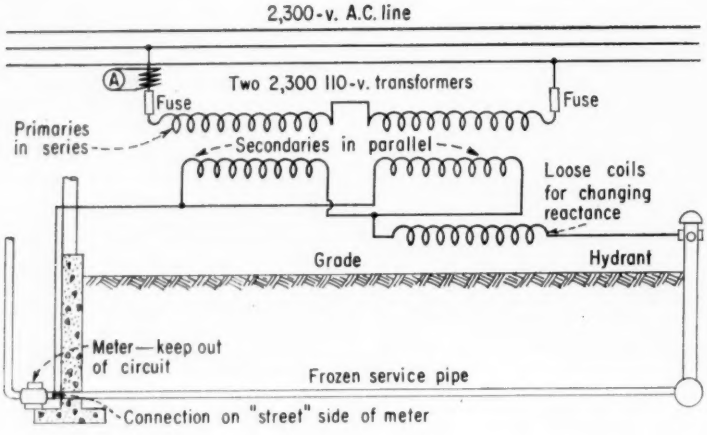
in resistance and a further increase in apparent viscosity, and so on, until flow in this line stops entirely. Thus, we have a situation of unstable equilibrium: the farther it goes, the farther it goes. In instrumentation terms, this can be considered a case of positive feedback.

Fig. 2 shows the hookup which cured these difficulties. Instead of trying to control the quantity of flow through the recirculation line, we controlled the time during which it was wide open. The valve in the recirculation line is operated by a timer, so that it can be opened for short periods at regular intervals. With recirculation lines that were short (i.e., of low resistance) compared with the line to the dryer, we found that no valve would be needed in the dryer line. If both lines were of similar length, it was necessary to put a valve in the dryer line and couple both valves to the time switch so that one would be opened as the other closed.

We expected difficulty with the end of the line in the dryer baking solid while the paste was recirculating. This was not the case and we were, in fact, able to recirculate successfully for as much as 75 sec. out of every 2-min. period.

The recirculation line has another advantage in that it mixes partly worked material—which is therefore less viscous—with the incoming, more viscous material.



Let Electricity Thaw Your Pipes

Paul C. Ziemke
Engineer, Clinton, Tenn.

Several years ago (p. 214, Jan. 1956) an article of mine in the Plant Notebook described how you can use welding generators and out-of-service transformers to provide low-voltage, high-amperage current for thawing frozen pipes in the winter.

A number of readers expressed a desire for more information on this quick and handy method, so the following suggestions should be helpful in getting the most out of it.

Thawing frozen water lines can be laborious—and it can be dangerous too if open flames are employed. Wrapping the pipe in rags or blankets soaked in hot water is a messy operation, in addition to the fact that it can't be used at all in concealed or obscure places. Passing current through the pipe to produce the necessary thawing heat in place ends all that.

The simplest way to get the desired high-current, low-voltage power needed for thawing is, of course, to use a welding generator. This may be a d.c. generator of the motor-generator or gas-engine type, or an a.c. transformer-type welder. The first and last require a source of a.c. current. Lacking such a supply, the gasoline-powered rig is an excellent substitute, especially since it is usually truck-mounted and can be moved anywhere at a moment's notice. All these machines have the necessary instruments and controls for effectively controlling the current flowing in the affected water line.

Water thawing is generally done with currents of 100 amp. or more, at voltages of 40 to 60 v. However, such a voltage is not essential and higher voltages of 115 or 230 v. may be used if lower voltages cannot be secured. What really counts, of course, is the current that can be forced through the line. The amperage can be regulated by supplying the proper voltage, by selecting the proper length of pipe between the temporary current leads, or by varying the reactance of the secondary of the transformers. A simple way of achieving this last method of control will be described later.

As a general rule, 100 to 200 amp. will suffice for pipes in the range from ¾ to 2 in. in size. For lines of 2 in. to 6 in., 200 to 300 amp. will do, and 300 to 500 amp. for pipes of 6 to 10 in. diameter. The size of the lead cables must be commensurate with the current flowing. In most cases you can expect to have water flowing again within 10 to 20 min. after turning on the electricity.

Ordinarily, your power supply will be at 2,300 or 13,800 v. and you must step it down. If you have two 2,300 to 120-v. transformers, you can get 60 v. at the secondaries by connecting the primaries in series and the secondaries in parallel, as shown in the diagram. (You could get 40 volts by similarly connecting three transformers.) The transformers are protected with line fuses of required size and type, while a current transformer and

ammeter is installed in one of the primary leads to indicate the current flow.

The diagram also shows a simple way to control the current flow. This consists in the insertion of a coil of wire in the secondary circuit — either comparatively few turns of fairly large-diameter wire, or more turns of smaller wire. By compressing or expanding these coils like a spring, the reactance is changed to give the third method of control mentioned above.

There is another hookup that is occasionally used where only a 230-v., single-phase supply is available. This requires a two-stage transformation with three transformers. First, use a 230 to 2,300-v. step-up transformer to boost the supply to 2,300 v. This is then fed to two 2,300 to 115-230-v. transformers, with the primaries connected in series and the secondaries in parallel so as to secure the desired high-current output at 60 v. from the secondaries.

There are a few points in using electric thawing that must be observed. These are the same, whether the transformer or the welding generator is used. Particularly, these have to do with the connections to the pipe and the joints within the pipe.

Contact points where the conductors are attached must be free of all paint, grease or rust. Failure to secure good contact can cause the thawing to take much longer than necessary. You are working with very large currents and therefore need clean, bright contact areas which will conduct the current without heating or arcing.

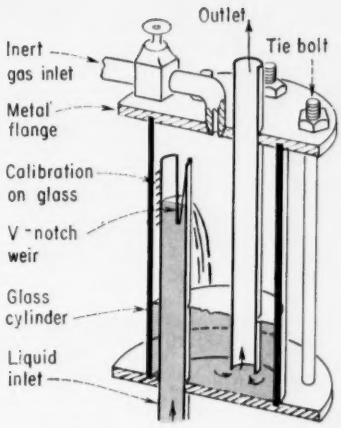
You should secure the conductors as close as possible to the frozen area and try to confine the heating to a minimum of pipe footage to secure maximum thawing speed. The actual connection requires a good mechanical means of attaching the conductors to the pipe. For example, "C" clamps make a good connection. If you use copper wire wrapped around the connection, be sure to check it frequently to see if heat has annealed the wire and loosened the connection.

Both the electrical service and the telephone are usually grounded to the water pipe and it is necessary to disconnect them temporarily while the thawing operation is going on.

Much of the success of electrical thawing depends on the conditions of the pipe joints. If the line is made up with lead joints, watch out for their low melting point. Badly rusted joints will have higher resistance and decrease the current flow, with corresponding increase in thawing time. Sometimes the line may have rubber-gasketed joints, held together with very rusty bolts—thus leading to high joint resistance. Occasionally you may find the line buried in soil which is either electrically conductive, thus acting as a shunt—or is thermally conductive—thus leading to excessive loss of heat.

Since thawing is generally done when the weather is cold, it is safe to overload the transformers considerably, say, 50 to 75%. Because of quick thawing the load will not last long, which will be another factor in making overloading quite safe for average transformers in fair operating condition.

In spite of possible difficulties, electrical thawing is generally the most convenient and efficient method, since it requires no laborious digging in frozen ground. And, once the water is flowing again, there are no disconnected joints or sections to be reconnected. One merely needs to disconnect the cables.



Weir Meter for Liquids Under Pressure

James Schad
Engineer, Wayland, Mass.

Here is an adaptation of the glass weir meter often used for liquids at atmospheric pressure (e.g., condensate discharge from a distilling column). Because it is designed to be pressurized with inert gas it can measure flow rates of liquids under pressure in pipes. It is accurate, inexpensive and easily fabricated in any shop. Note two points: (1) Make the diameter of the liquid inlet large enough to keep inlet velocity head low. (2) Make the distance between the weir bottom and the outlet pipe sufficient to take care of liquid pressure variations.

Next Issue: Build Your Own dP Controller

By M. S. Schwartz, Winner of the October Contest

★ How Readers Can Win

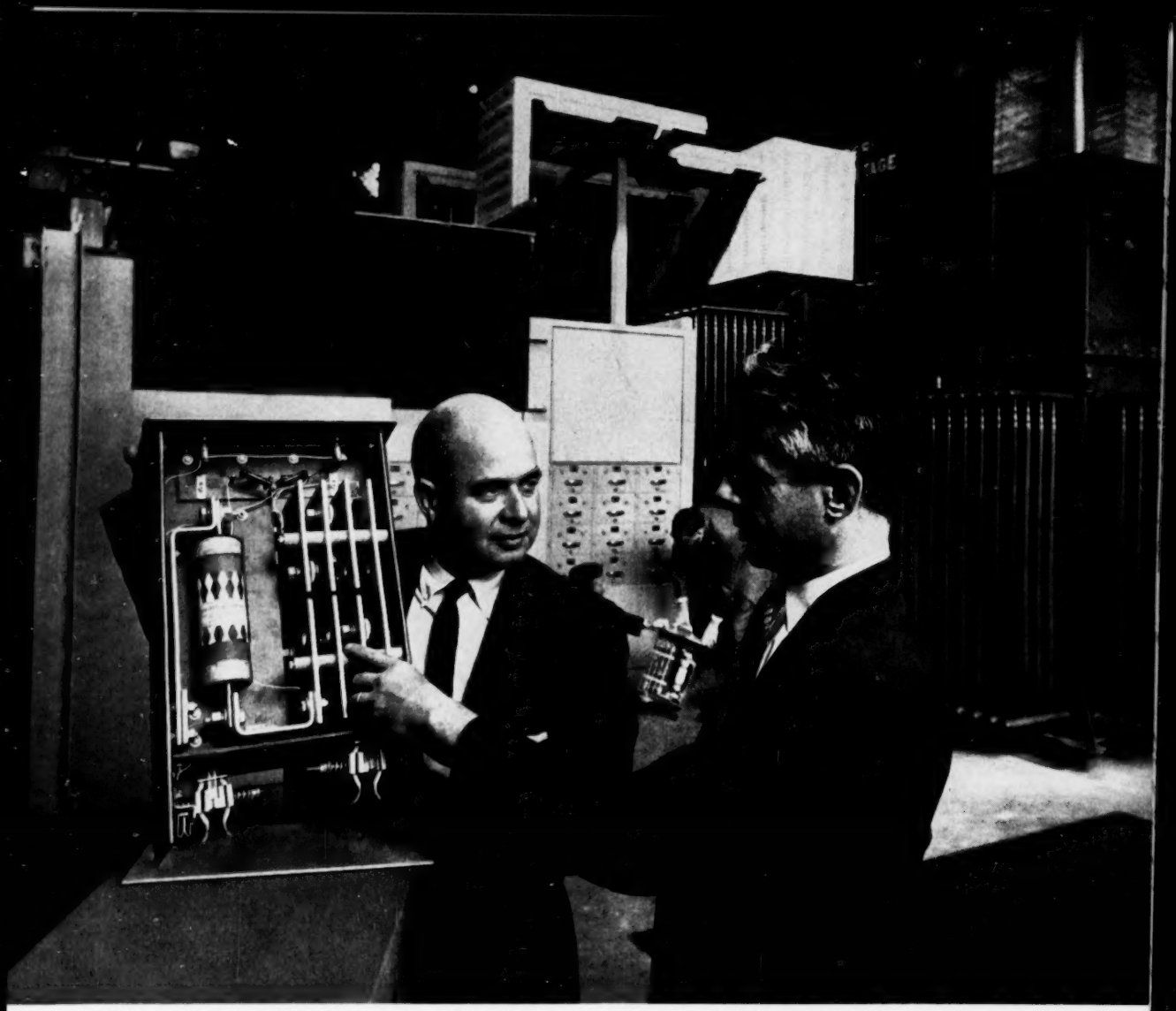
$50 Prize for Good Idea—Until further notice the Editors of *Chemical Engineering*, will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebooks.

Each period's winner will be announced in the second following issue and published in the fourth or fifth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.



HEART OF THE NATION'S LARGEST SILICON POWER RECTIFIER INSTALLATION is the silicon rectifier tray, shown here being discussed by W. S. Heston (left), General Electric, and Donald E. Springer, Chief Engineer for the Hooker Chemical Corporation, Niagara Falls, New York.

Built by General Electric for Hooker Chemical Corporation

Nation's Largest Silicon

SILICON RECTIFIER EFFICIENCY IMPROVES POWER OUTPUT, REDUCES EXPENSIVE DOWNTIME ON CONTINUOUS PROCESS LINE

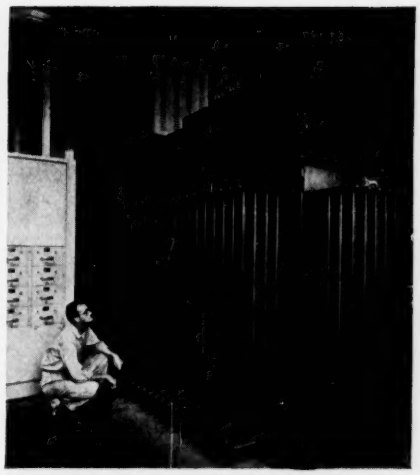
As the trend in the Northeast from 25-cycle to 60-cycle power gained momentum, Hooker Chemical Corporation had to modernize its power conversion system. As a result, Hooker's Niagara Falls, New York, plant installed the largest silicon power rectifier system in the nation—with equipment completely system-engineered and built by General Electric.

The four 96-tray silicon rectifier circuits of the system were designed to replace 12 rotary convertors. The rectifier system services 55 per cent of the plant's Hooker Type S cells, which produce chlorine, caustic soda and hydrogen, and 24 per cent of Hooker's power consumption at Niagara.

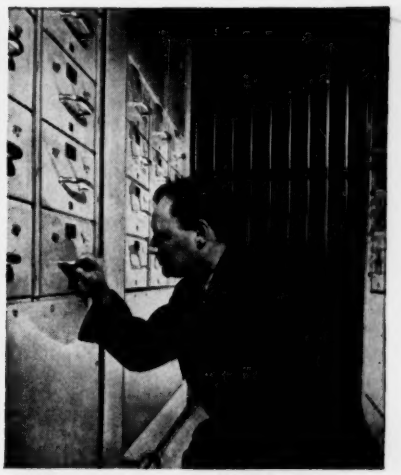
For this continuous process line, operating 24 hours a day, seven days a week, the basic simplicity and efficiency of the General Electric silicon rectifier system was explained this way by Donald E. Springer, Hooker's chief engineer: "The silicon rectifier system will save space and lower maintenance and operating costs appreciably. Replacement of the silicon rectifier tray is a matter of seconds, and does not involve downtime of the unit.

"There are no large moving masses, no noise, less heat. We expect the system to provide about 5 per cent more usable power output than the rotary convertors."

IABLE SYSTEM CIRCUIT PROTECTION and meter- is furnished by G-E metal-clad switchgear. Vertical design provides greater safety, easier maintenance.



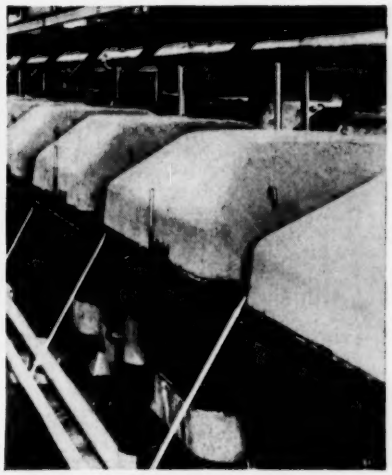
ADJUSTABLE, AUTOMATIC DC CURRENT control of the load by a G-E Pyranol† Inductrol voltage regulator helps assure more accurately-controlled power.



SIMPLICITY of G-E air-cooled silicon rectifier design permits tray removal in seconds, requires no system downtime.

ERAL ELECTRIC DC CURRENT TRANSFORMERS uce system installation cost, increase safety. The ent transformers are used in metering circuits.

REMOTE CONTROL of four circuits is permitted with G-E main control panel. Separate control panels for each circuit help assure more efficient use of power.



SILICON RECTIFIER SYSTEM OPERATES Hooker Type S-3A cells, similar to these, for chlorine-caustic soda process.

Power Rectifier System

om AC to DC, the silicon rectifier power system was signed with General Electric equipment to help assure e most economic use of electric power. Adjustable, tomatic DC current control of the load to within 1% is accomplished by a General Electric Inductrol* ltage regulator. The cleanliness, simplicity and ease of intenance of the air-cooled silicon rectifier units help oid costly downtime. The entire system is tied together th easy-to-install General Electric LVD busway and mor-clad cable.

nit responsibility is the key to maximum coordina- n of the system equipment in the Hooker installation. ecause Hooker selected one supplier, General Electric uld offer its engineering know-how and system- gineered equipment in a combined effort. The result for Hooker was a more simplified, efficient and economical electrical system.

For more information on General Electric's system-engineered equipment and technical assistance, contact your nearest General Electric Apparatus Sales Office. Meanwhile write for bulletin GEA-6684A, "Semiconductor Rectifier Power Conversion Systems," from the General Electric Company, Section 686-2, Schenectady 5, New York.

*Registered trademark of General Electric for induction regulators.
†Registered trademark of General Electric for Askarel.

Engineered Electrical Systems for the Electrochemical Industry

GENERAL ELECTRIC

Stress and Strain on the Salary Structure

What will your salary be five years from now? Let's tune in on a management discussion of this important topic.

This week, as you gnaw the last remaining shreds of dark meat off your Thanksgiving turkey carcass, management will be carving proposed 1960 operating budgets into final form.

Taking their lead from the giant steel companies, many managements in 1960 will be digging in for a last-ditch defense against inflation, the wage spiral and featherbedding.

Sharp pencils will be poised threateningly above budgeted figures for total employment costs. Wages, salaries, fringe benefits and pay for time-not-worked will undergo the severest scrutiny that they have been exposed to in the past two decades.

The cost of keeping you on the payroll—especially the cost of keeping you *happily* on the payroll—will be examined carefully by engineering managers; by corporation wage and salary administrators; and by top management, itself.

If you are successful in convincing your own department head that your salary must continue to rise steadily and significantly in the years ahead, the next hurdle you face is that of convincing the man responsible for wage and salary administration at the corporate level.

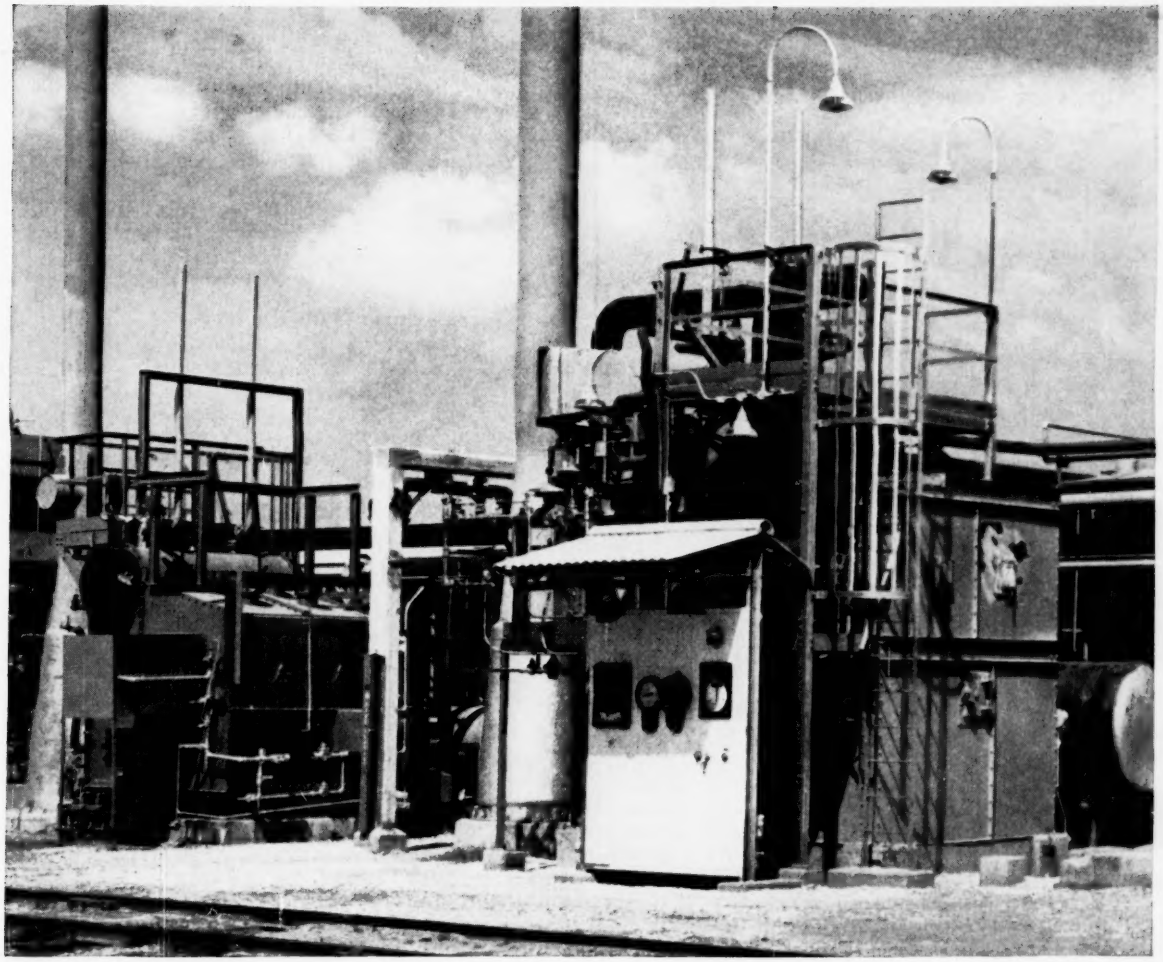
Although this may sound like a formidable task, these wage and salary fellows are only human, after all. Occasionally they get together, let their thinning hair down and tell each other what they are really thinking. One of their favorite trysting places is the Fall Personnel Conference sponsored by the Personnel Division of the American Management Assn.

This fall an entire session of the conference was devoted to wage and salary structure and planning for tomorrow. Some of the ideas presented by the speakers—representative of top management thinking today—are worth your careful consideration. After all, knowing in advance the strategy planned by your opponent is a superb piece of competitive intelligence. So let's listen in on what these corporate wage and salary administrators were telling each other.

▶ **Divine Discontent**—What are some of the underlying causes behind the stress and strain on today's salary structure?

Chester C. Payne, Director of Salary Administration for the Dow Chemical Co. offered an analysis of this problem. According to Payne, here are the nine most significant factors:

• Man is blessed with divine discontent. The American free enterprise system has spent billions of dollars in advertising to make people discontent with their present circumstances. Practically all Americans have learned the lessons we have tried



The open secret that makes leading processors choose Foster Wheeler vaporizers again and again

When this picture was made, the Foster Wheeler vaporizer on the left had been in service for over three years, supplying 2,300,000 Btu per hour for processing of ethylene oxide and ethylene glycol, using Dowtherm as the heat transfer medium. When plant expansion became necessary, the processor again chose a Foster Wheeler vaporizer, the 3,700,000 Btu unit at right.

Such repeat installations have become virtually standard procedure for many of the process industry's blue-ribbon companies. One, for example, has placed 68 units in service over the course of 26 years.

This customer confidence is based on an "open secret". To make sure that the vaporizers are being applied to the best possible advantage, Foster Wheeler engineers review the engineering details of the entire process heating system. They use this information to tailor the vaporizer to the system. And in doing this, they are often able to make suggestions that result in savings for the processor, or a more efficient process.

Get full technical information on Foster Wheeler vaporizers and the *Heat Engineering* service that goes with them, by writing to Foster Wheeler Corporation, Dept. D, 666 Fifth Avenue, New York 19, N.Y.

Heat Engineered products, plants and processes . . . for the world's industrial progress.

FOSTER WHEELER

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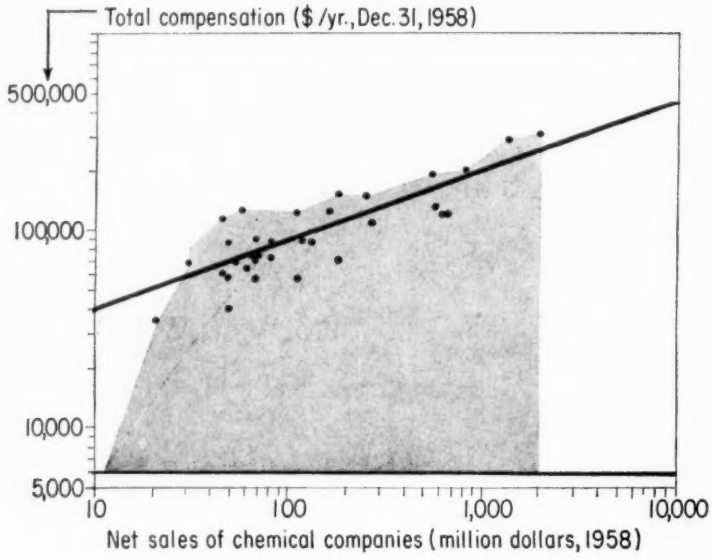
Limits of Your Salary Structure Are the Pay of Top Executives and New Graduates



to teach them. They are now conditioned to expect more each year, regardless of sales, profits or other circumstances.

• Inflation has pushed the salary structure upward and will continue to do so.

• Rising hiring rates paid to new college graduates each year is a constant problem.

• A continuous rise in rates paid to hourly employees also creates problems in the salary compensation structure.

• Often, unfortunate timing of raises to union employees is also a real cause of stress and strain. And this is a separate problem from the amount that is given. Sometimes we are forced to raise wages of union employees while major economic readjustments are necessary in other company operations. (This was brought home to us during the recession of 1958.)

• Millions of workers today are protected by cost-of-living escalators that go up, but not down. Again using 1958 as an example, workers were getting automatic increases at a time when sales and profits were plunging downward.

• Concern with how salaries compare within a company. Salesmen feel that the real money is in production; production is sure that the real money is in research; researchers are positive that the company really favors its sales force.

• We have created terrific problems for ourselves by making salary information much more public than it used to be. It seems that almost every organization, society, college or other group is trying to sponsor a salary survey; and of course they want to publish the results for all to see. After the results are published repercussions are immediately felt in industry.

The 50% of those surveyed who are below the median are automatically unhappy with their salaries. The 50% who are above the median become unhappy because they feel they are not far enough above the median.

• The causes listed above create upward pressures on the salary structure. The most potent downward pressure on the structure is the profit squeeze. Costs have gone up at the expense of profits.

After enumerating these nine causes of stress and strain, Payne elaborated on some of them. For instance, here's the Dow attitude on making salary information public:

"It is not at all unusual to find companies where almost everyone knows the salary grade of most technical jobs, together with the minimum and maximum which are paid for each grade. I feel this immediately raises two problems:

"1. Bickering often results as to why a salesman is in Grade 12, the accountant in Grade 10, the research engineer in Grade 11, etc. I do not believe it is possible to satisfactorily explain the evaluation of accounting jobs to the average salesman; or vice versa; or the evaluation of research jobs to the average production worker, or vice versa.

"2. The second thing which usually happens is that a high percentage of employees immediately become concerned about the ceiling on their job. Since they always know their salary grade and its ceiling, they are concerned throughout a large portion of their industrial career about this problem. It seems to me that for most employees during most of their industrial career this is a rather needless strain.

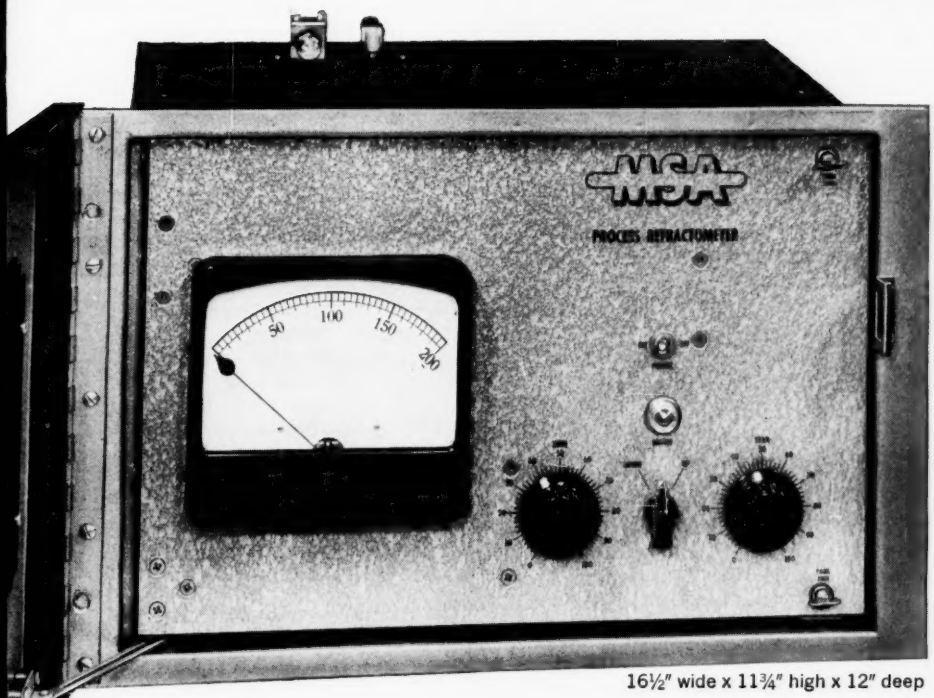
"Let me show you what I mean with a specific example. Let us suppose that we hire a new engineer for $500/month and immediately put him into a salary grade whose range is from $450 minimum to $675 maximum.

"I believe that a study in almost any company would show that almost all such engineers would, with experience, progress to a job with a considerably higher ceiling than that placed on the beginning engineer. Thus, perhaps 95% of such people will grow into a job with a ceiling close to $1,000/month. Why should we have these people spending a major part of their industrial career worrying about a ceiling problem which is not at all realistic?"

▶ **The Real Ceiling**—If you follow Mr. Payne's advice and remove yourself from the ranks of the worriers, if you banish those imaginary ceilings from your immediate horizon, what are the actual limits on your salary in the years ahead?

The chart on this page shows the upper and lower limits of the

NEW M-S-A® PROCESS REFRACTOMETER



16½" wide x 11¾" high x 12" deep

measures components of organic and inorganic streams in these typical applications:

Acetone in water
Alcohol in water
Ammonium sulfate in water
Benzene in cyclohexane
Benzene in ethanol
Boron chemical processing
Brine concentration
n-Butane in isobutane
Butadiene purity
Citrus juice blending
Cyclohexane in benzene
Cyclohexane separation from normal-hexane
Distillation control
Ethanol in benzene
Ethanol in water
Ethylene glycol in water
Food products
Gasoline additives
Gasoline fractionation
Glycerol in water
Hydrogenation of food oils
Isopropyl alcohol and methyl ethyl ketone in secondary butyl alcohol
Isopropyl alcohol in water
Methanol in water
Monitoring chromatographic columns
Nitric acid in water
Polymerization control
Propylene glycol in water
Separation of aromatics
Sodium chloride in water
Stream blending
Styrene in ethylbenzene
Sugar concentrates
Sugar in water
Sulfuric acid in water
Vinegar production
Water in acetic acid
Water in ethanol
Water in methanol

WHERE TO USE IT

You can use the new M-S-A® Process Refractometer for industrial applications in production or research. This unit controls either stream or batch processes. Measures and controls product quality. Solves a variety of problems requiring rapid, accurate determinations. Conversion to *new* problems is quick and easy. We've listed some typical applications at the right.

PRINCIPLE OF OPERATION

The M-S-A Process Refractometer depends on the differential refraction of light passing through two materials which may have different refractive indexes. It detects and measures the change in light bending due to a variation in refractive index of a "sample" relative to a constant standard. This variation is detected by a Cadmium Sulphide Photocell Circuit.

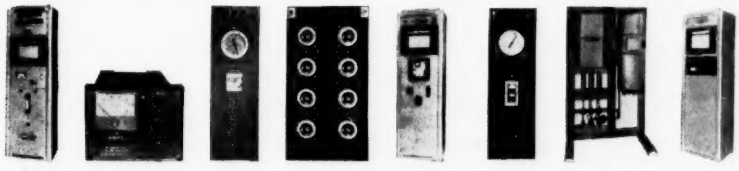
SPECIFICS

This is a high sensitivity instrument: 0 to .005 RI units full scale. Accuracy is ±1% full scale or ±.000005 RI, whichever is larger. Zero drift is 1% full scale or less per day. Response is 90% in 30 to 60 seconds. Sample flow required: 5 to 20 cc/minute. Available in explosion-proof or non-explosion-proof construction. Power needs: 50/60 cps—100 watts—115 volts.

MSA ASSISTANCE

MSA Instrument Specialists, implementing more than 30 years of MSA experience in gas analysis, can help shed some light on your sampling problems. First, perhaps you might like to look over our technical bulletin on the new M-S-A Process Refractometer. We'd like to send you a copy in the return mail. Write, wire, or phone MSA's Instrument Division, Pittsburgh 8, Pa.

Complete Line Instrumentation for Process Stream Analysis



M-S-A® LIRA® Infrared Analyzer Model 200

M-S-A® LIRA® Infrared Analyzer Model 300

M-S-A® Inert Gas Analyzer

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M-S-A® Thermatron Analyzer

M-S-A® Oxygen Indicator

M-S-A® Water Vapor Recorder

M-S-A® BillionAire® Analyzer

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INSTRUMENT DIVISION
Mine Safety Appliances Company
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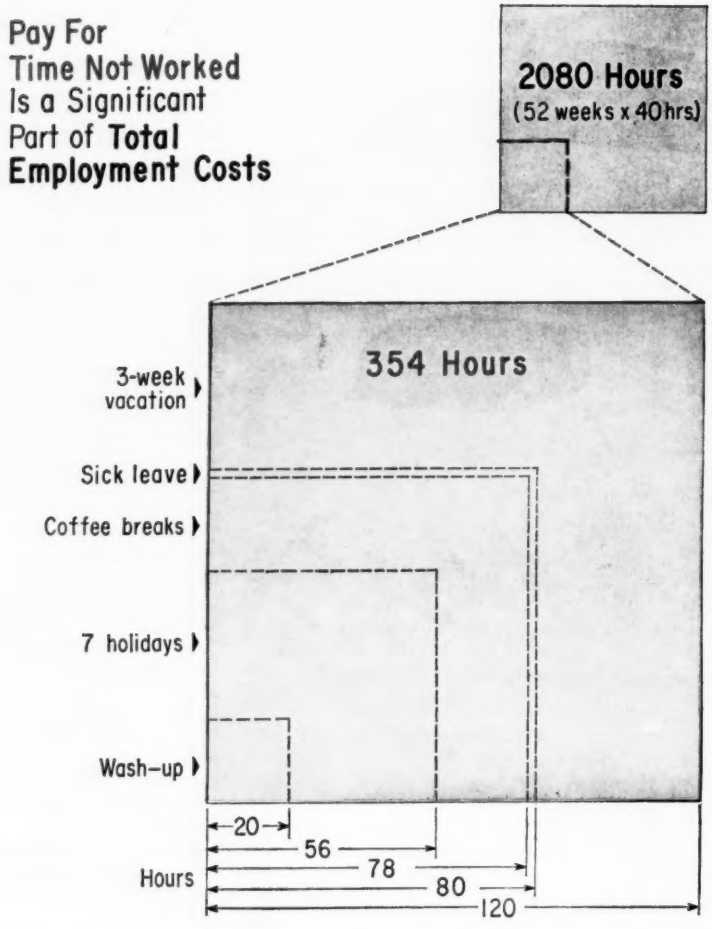


chemical engineer's salary structure. At the bottom we have the offers made to new graduates. Members of the Class of '59 began their industrial careers at about $490/month.

At the top you have the chief executives of chemical companies. Their total compensation figures for the year 1958 are plotted as data points on the chart. Each point represents one chief executive and one chemical company. Note the correlation between the level of compensation and the net sales of the company. The line in color represents the industry trend line. Data are taken from the Sept./Oct. 1959 issue of *Harvard Business Review*.

Your salary is somewhere within the gray area of this chart.

▶**Let's Trade Data**—If those wage and salary administrators who listened to Mr. Payne at the AMA meeting agree to adopt his attitude against the public disclosure of salary data, you can be certain that this will not stop the private exchange of this type of information.

Here's what Thomas A. Cooper, Manager of Wage and Salary Administration, The Budd Co., had to say about this:

"One of the most important factors in wage determination is the level of compensation in competitive firms in the area. Accordingly, a periodic survey of pay rates prevailing within an area or an industry is an essential step in establishing and maintaining wage rates which are equitable and which will insure an adequate labor supply.

"I believe this statement from the 'AMA Handbook of Wage and Salary Administration' can be used as keynote for our discussion. Wages and salaries paid in the area or industry for comparable work are probably the greatest influence. Wage and salary surveys are used to obtain this information.

"All those responsible for wage and salary administration functions should endeavor to establish contact with a variety of organizations who conduct wage and salary surveys . . . member companies are also usually more willing to cooperate on a tell-all basis where there is a restricted membership and closely guarded distribution of survey data."

Membership in these groups is usually restricted to companies of similar size, location, employee and classification distribution.

▶**What About Tomorrow?**—When one starts to think in terms of plans for tomorrow, the usual procedure is to review the present and the past. This was the approach that Burton E. Bauder, Director of Compensation and Benefits, American Airlines, used in discussing the salary structure of the future.

Bauder predicts a shorter work week; more automation; more extensive application of wage incentives; a shift from blue-collar to white-collar employment; continued liberalization of fringe benefits; and an increase in the pay for time-not-worked.

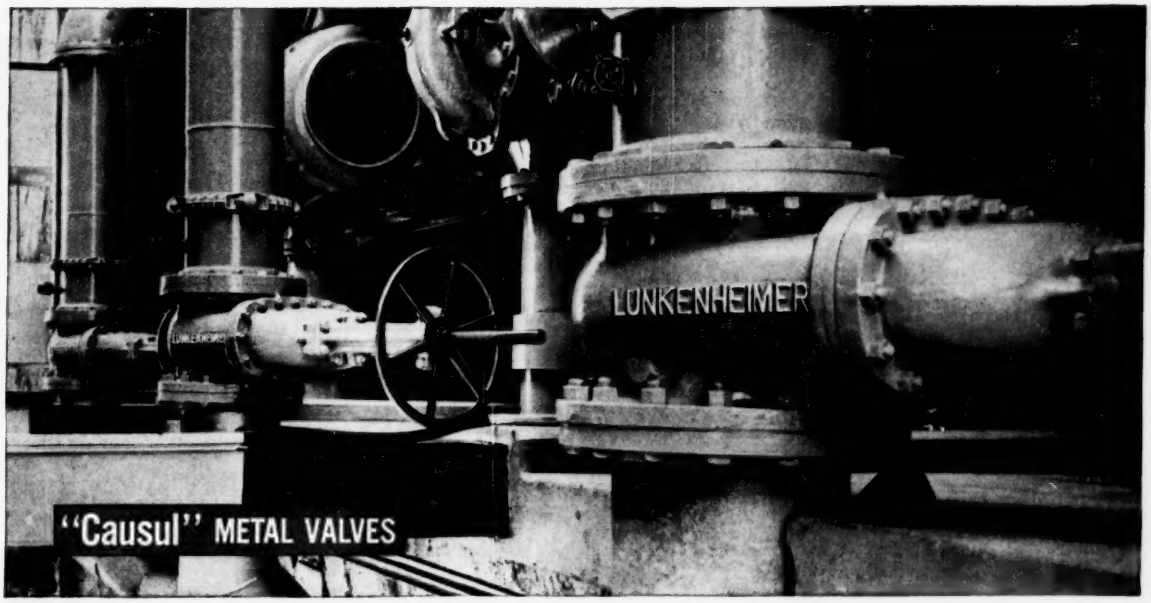
It's surprising to note how significant this last item has already become in most companies. The chart on this page tells the story graphically. Note that it assumes a 40-hr. work week. Many engineers are already working less than that each week. The 35-hr. work week is becoming a common office phenomenon.

The conference session concluded on this note: "The outlook for the immediate years ahead . . . squeezed middle-management salaries, the impact of organized and subordinate rates on supervisory salaries, profit sharing and the many other techniques that are being considered by progressive companies as part of an over-all, well-integrated compensation structure."

Here's a balance between

Economy and Corrosion Resistance

that cuts your plant maintenance costs!



High alloys cost money—big money. They also offer the best corrosion-resistance you can buy. Ordinary iron or bronze, on the other hand, is inexpensive—but it can't hold up in corrosive service.

That means you need *balance:* a body and bonnet with *good* corrosion resistance at a reasonable price, and trim—where the most protection is needed—with *excellent* resistance. And that's the combination you have right here. "Causul" Metal, a Lunkenheimer exclusive, has much more resistance to corrosion than bronze or gray iron. At the same time, it's a lot less expensive than the high alloys. And when you couple these bodies and bonnets with trim in Type 316 Stainless Steel or Monel Metal, you have a real money-saving combination for many corrosive services.

Screwed Ends
Fig. 1910-8
(Monel trim)
Fig. 1910-4
(Stainless trim)
½ to 2 inches

Flanged Ends
Fig. 1911-8
(Monel trim)
Fig. 1911-4
(Stainless trim)
1 to 3 inches—
clip design
4-6-8 inches—
bolted design

Today, the minute a maintenance man touches a wrench to a valve, its cost can double! Find out how you can cut these maintenance costs to rock-bottom with "Causul" Metal Full-Way Gate Valves.

YOU ARE INVITED TO
INSPECT THESE VALVES
AT BOOTHS 1380-82 AT
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The Lunkenheimer Company
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FREE Piping Practice Wall Chart on Valve Selection, Installation, Maintenance.

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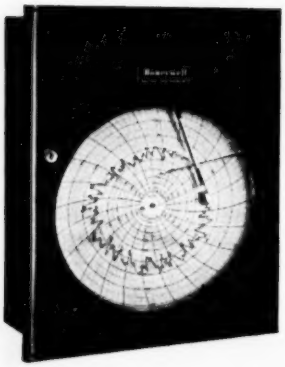
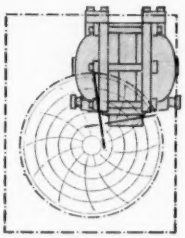
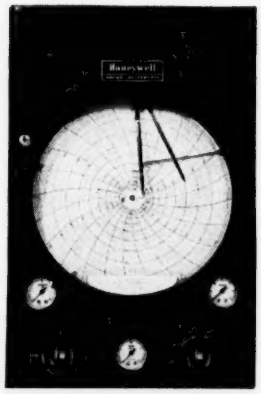
HERE ARE FOUR OF MANY WAYS YOU CAN USE THE BELLOWS FLOW METER



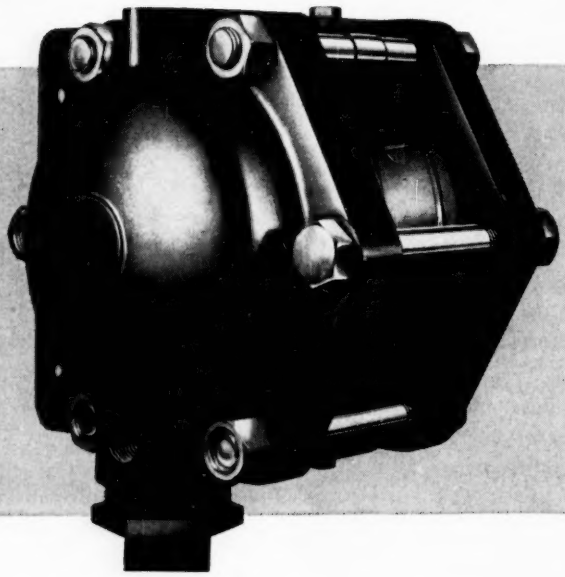
For direct measurement and control

the meter is integrally mounted on indicators, indicating controllers, recorders, or recording controllers.





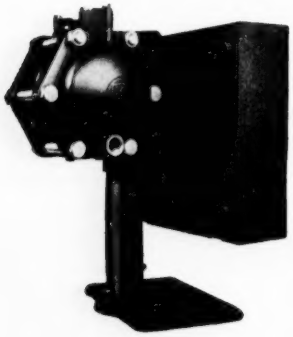
With an indicator or recorder—Indicators can be supplied with or without pneumatic transmission. Recorders can be one, two or three-pen instruments, with the second and third pens actuated by thermometer and/or pressure elements.



With indicating or recording controllers—All indicators and recorders can be supplied with any pneumatic control form from on-off to three-mode. Indicating controllers are also available with pneumatic transmission.

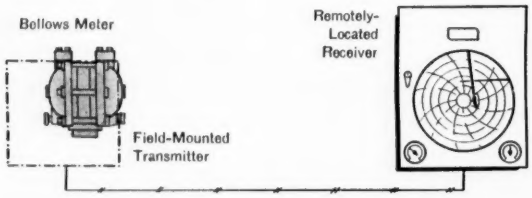
With a "blind" transmitter—the non-indicating differential pressure transmitter is used when indication is not required at the process and the variable is to be transmitted to remotely located instruments.

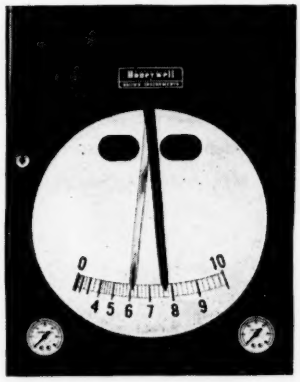
With an indicating transmitter—Scale is graduated in accordance with the flow or liquid level span of the transmitter. These transmitters are available with pneumatic control to remotely operate final control elements.



For remote measurement and control

Field-mounted transmitters, either "blind" or indicating, can be used with remotely located indicators, recorders, and controllers.





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Here's the most advanced meter body available today, with advantages never before found in flow and liquid level meters. Combine the new Honeywell Bellows Flow Meter with the instruments shown on the facing page for truly superior service in metering steam, water, gas, oil and other fluids.

Some of its outstanding features:

Sensitive and accurate—Sensitive to within 0.05% of full scale . . . calibrated accuracy ± 0.5% of full scale.

Leakproof—Between liquid fill and process fluid.

Automatically stabilized—Changes in meter body temperature or static pressure have no effect on output shaft position. Meter operates efficiently in ambient temperatures of minus 40°F to plus 250°F.

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High corrosion resistance—Seamless, stainless steel formed bellows give long, trouble-free service with virtually all process fluids.

Fast, effective damping adjustment—New type pulsation check with rectangular orifice permits essentially linear damping adjustment . . . and adjustment from outside the meter body during operation.

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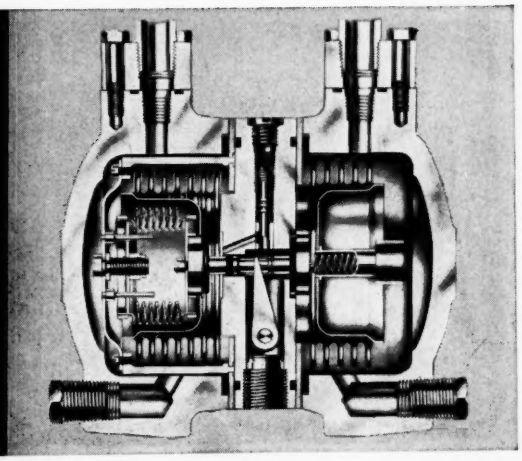
MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

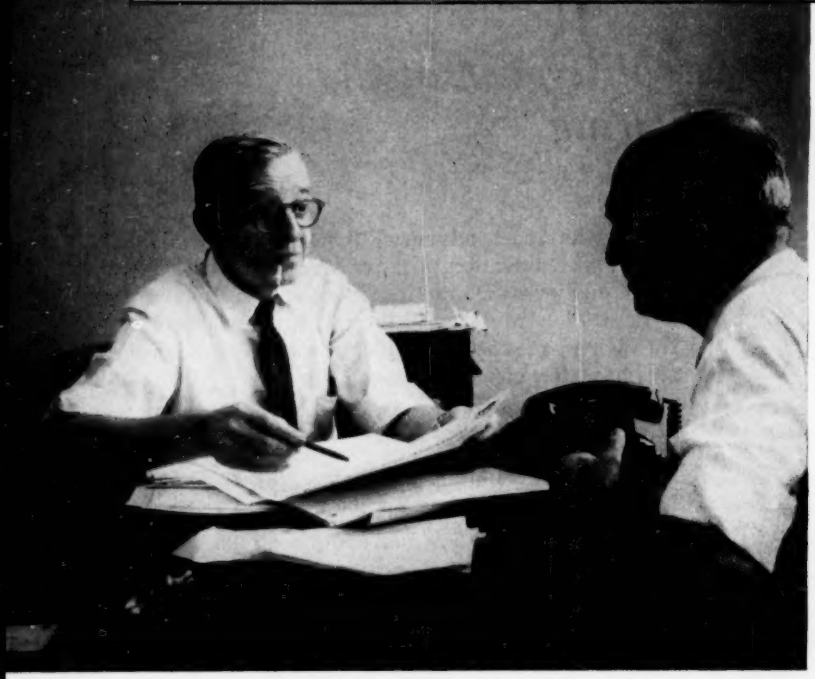
● **REFERENCE DATA: Catalog C22-1**



Transfer of liquid between opposing high and low-pressure bellows converts differential pressure measurement into motion. A torque tube assembly carries the motion outside the meter body to an instrument. Therefore, changes in differential pressure change the instrument reading.

Honeywell

First in Control



How to Stamp Out Inventory Cheating

Here's the inside story about a little known but surprisingly widespread practice—how it's done, how to stop it.

WINGATE H. RICHARDSON, Consultant, New York, N. Y.*

Back in the days when I was in school, the head of the department used to emphasize at frequent and regular intervals:

"The primary purpose of any manufacturing operation is to make a profit."

Today, I think we frequently lose sight of this goal. A large number of organizations, the government, much of the research done today, the military establishments—all are by design, nonprofit. So it might be well to point out, there's still a large segment of our economy where it's downright necessary, to operate at a profit.

*To meet your author, see *Chem. Eng.*, Sept. 21, 1959, p. 176.

► **Profit Has to Show**—The accounting department is the place that must answer the questions: Are we making or losing money, and in either case, how much?

A considerable amount of the data the accounting department needs for answering these questions comes from the operating departments of the company. Material accounting is an important part of accounting operations and is generally the responsibility of the operating department. It can be the source of some real headaches to production men.

► **Answer These Questions**—Expressed in basic terms, material accounting is a very simple matter. There are only five basic questions to answer.

- How much material did you have on hand at the beginning of the month?
- How much material did you receive during the month?
- How much material did you have on hand at the end of the month?
- How much did you ship?
- What the devil happened to the rest of it?

Of these five questions, two are comparatively easy to answer: What did you receive, and what did you ship?

Answers to these questions are generally cross-checked with the receiving and shipping department against bills of lading and again with the accounting department against bills receivable and bills payable.

The two questions: What did you have on hand at the start of the month, and what did you have on hand at the end of the month, are not so easy to answer. A good part of this material may be in process and even in a relatively simple process may represent a large tonnage or dollar value in comparison with the month's production.

Since it's frequently difficult to measure and difficult to properly

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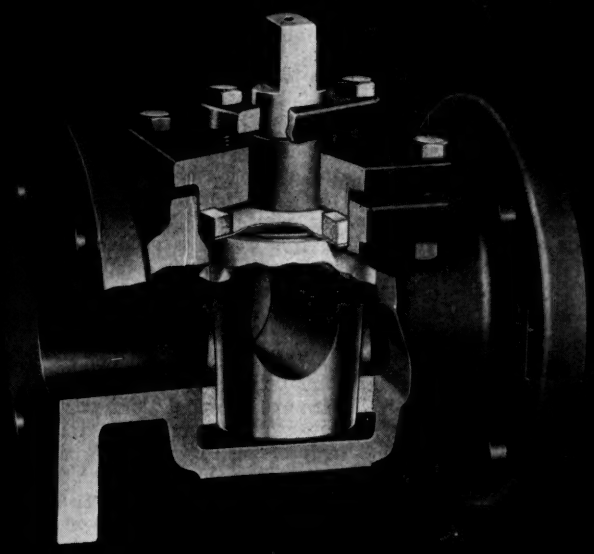

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"Entirely satisfactory in service on 66°Bé sulfuric acid after 8 months."

latex user

"Valve on Latex service since May 1, has given no trouble. Other valves (gate, globe, ball, wedge, lift plug) failed because Latex build-up froze the valve."

chlorine gas service

"In service for ten months on chlorinator handling dry chlorine gas at 50 psi —ambient temperature. Formerly used lubricated valve which gave considerable trouble due to freezing."

caustic service

"Valves used on cell liquor, concentration 12%, at 160°F. After one month valve was removed and inspected. All movable parts were free, no wear was evident. Valve was reinstalled and has been in six months continuous service with completely satisfactory performance."

phosphorous user

"Used on yellow phosphorous at 160-200°F. Valves are doing fine. Thanks for a product that works—and a valve that I can turn with one hand without breaking my back."

solvent handling

"Valves performing very well on toughest solvent service after five months, where lubricated plug valves were regularly replaced due to sticking caused by leaching out of lubricant."

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proportion between raw material and finished product there's considerable room for error. Generally a fair amount of judgment must be exercised in reporting in-process inventory.

The last question: What the devil happened to the rest of it, is the source of the real headaches for production men. This usually takes the form: What was your yield?

If the yield is lower than the established value, there's really no satisfactory way to explain this to management. If you were careless or made errors of judgment, you certainly don't want to offer this is an explanation. Any other explanation is under suspicion as an excuse for carelessness anyway.

Under such conditions there is a strong temptation to juggle the inventory figures since this is the only place in the entire accounting procedure where skulduggery has a possible chance of success.

▶ **Falsification Isn't Uncommon** —Falsification of inventory figures is a dishonest practice and no amount of rationalization changes this fact. Nevertheless, it's a fairly widespread practice in industry. When this is done to achieve a profit based on the value of the inventory this is fraud and is punishable.

Cases of interest to you, the operating man, however, are those where inventory juggling is resorted to in order to protect or enhance the reputation of the operator with his management, or to present a favored process or operation in a better light. To put it in the simplest terms: to keep from being called up on the carpet in the front office.

▶ **My First Encounter** — I was assigned to an existing operating department with instructions to make a thorough study of the process and equipment and to make such changes as necessary to improve yields and operating efficiency.

The first few months of my time were spent in becoming acquainted with the process and operating practices and making such minor changes as were obviously desirable and which could be made without interfering with production operations. During this period I watched the reported yields carefully since improvement was one of my major goals.

A complete inventory was taken each month and from this, along with records of material received and material shipped, yield was calculated. The complete monthly report was sent to the accounting department.

In addition to this "official" report, a trial inventory was taken about the middle of the month and again about the 25th to be sure everything was going along all right.

▶ **Enter the Kitty** — Not long after I was assigned to the department, a trial inventory taken toward the end of the month showed we could expect a very low yield on the monthly production report. I was pretty concerned about the reaction from the front office and expressed my concern to the department head.

"Oh, don't worry about that" he said, "I'll take a little out of the 'kitty' this month. The figures will look all right when they go up to the front office."

Well, of course, I had to ask just what the "kitty" was.

"Oh, haven't you found out about that yet? Well it's this way. When I have a real good month nobody ever mentions it to me but when I have a bad month, I catch hell from the front office. So I quit reporting good months. I cut the inventory figures down until I showed a normal yield . . . and the material I have in inventory that I don't show in the report—well that's the 'kitty.' Then when a bad month like this comes along, I've got a little cushion and can show a satisfactory yield."

▶ **Management Shares the Blame** —A lot of moralizing can be done about this episode. If management used a little better judgment in balancing praise and censure there would have been less need for a "kitty."

What do you do if you have a run of poor months? Use a "negative kitty?"

But from my point of view, that is, the improvement of the operation, some very serious problems were raised. In the first place, I could not count on records of past performance to correlate yields with operating variables, catalyst life for instance. And in the second place, of course, current records were unreliable.

This then became a major project, to correct the material accounting methods. This was quite a task. A full discussion of the problems encountered and final solutions worked out is a subject by itself. There were two interesting highlights that might be mentioned.

▶ **New Material Balance Set-up** —I recognized that a once-a-month material balance was inadequate and a form was prepared and a procedure developed for making a complete material accounting for each 24-hr. period. This was retained as standard operating procedure.

For a period of about two months, a complete balance was taken every 8-hr., that is, each shift was held accountable for their operations. These 8-hr. results were averaged over a 2-mo. period for each crew. Results pinpointed some troubles due to operator incompetence and these troubles were then corrected.

▶ **We Studied Old Records** — Toward the end of the program it became apparent that a study must be made of past operations in spite of the unreliability of the monthly yield figures.

Monthly production figures were obtained from the accounting department covering the entire life of the operation, a period of about fifteen years. Yields were plotted by months but it was apparent that monthly variations were too erratic to permit any sound conclusions.

Then, I decided to calculate, for each monthly production period, the cumulative yield for the preceding 12 mo. Calculated in this way, the production figures were large in comparison to the inventory figures, and the effect of inventory errors was minimized.

While I recognized that short-range effects of operating variables are obscured along with the inventory errors, there was no way of getting this information anyway so that this wasn't considered a loss.

The resulting curve was smooth as might be expected. It indicated the operation had started with a fairly low yield which increased steadily for a

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period of about three years. Then there was a gap while the plant was out of production for a short period. When production was again started, yields were again low but climbed about as before.

Yield reached a peak about five years before the start of the development program. After this period yields went steadily downward. The last five months yields went steadily upward. This period followed the changes made as a result of the development program and was, of course, highly gratifying.

Armed with this curve I asked the department head if he had any records of his past operations. Fortunately, he kept an operating log and had fairly complete records.

▶**And Found Our Answer**—We sat down to find out what changes were made at various periods where noticeable changes in the slope of the curve, occurred. A number of useful bits of information were uncovered but the most startling was the explanation for the steady drop over the last five year period. I said:

"What happened here at the peak of the curve?"

"Oh, that was the year we got a batch of catalyst contaminated with iron. We tried to operate for several months but the yields were so low we finally shut down and replaced the catalyst." That explained a short term change in the curve but didn't explain the continuing drop over five years.

"What did you do with the contaminated catalyst?"

"Well," he said, "that's a pretty expensive item and I didn't want to mark it off as a loss so I carried it in my inventory. Each time I make up a new batch of catalyst I add about 10% of that old catalyst. I've only got a little bit of it left now!"

The catalyst is added to a carrier that's reused and so the iron which caused such an apparent drop in yield in the original run had been added piecemeal until it was now nearly all back in the process.

▶**Cheating Comes in Many Colors**—Sometimes inventory juggling is resorted to for personal reasons that are pretty grubby. One morning I got a telephone call telling me that one of our department heads had passed away suddenly during the night. Joe had been with the company a long time and his loss was a shock. He was a conscientious and capable employee.

Shortly thereafter his department was turned over to Charlie, a young go-getter, who was building up a good reputation for himself in the organization.

Of course, the first thing he did was to make a complete inventory. When he reported the results, we got quite a shock. The actual physical inventory was considerably short of the figures Joe had been reporting.

The product was a high-cost, small-volume material and the dollar loss was considerable. There was no way, of course, of recovering the loss and the whole business was kept pretty quiet.

Well, as they say, time passes on. A few weeks later, difficulties in negotiating a new labor contract, resulted in a strike and operations were shut down. During the strike we continued as far as possible to supply our customers' needs. The materials we could deliver were limited to the small-volume, high-cost material, such as that from Joe's old department, which could be taken out of the plant in a station wagon or private car.

Of course, by now you have probably guessed what happened. After a few weeks of this operation the accounting department suddenly noticed that we had shipped large quantities of material from Joe's old department that had never been produced.

Here again was our old friend the "kitty" at work, this time having been set up in advance by Charlie the go-getter to protect himself against possible disaster during the initial period of his responsibility for the department. Charlie's blossoming reputation suffered a severe setback.

▶**Don't Count on Your Luck**—There is one other type of inventory problem that frequently is a source of trouble. This is the case of down-grade product or poor quality in-process material. One case comes to mind.

We were involved in a process for extracting a product from a naturally occurring raw material. The process had been developed in the laboratory and appeared to be a very simple operation. Economic studies indicated an excellent financial return and in a burst of enthusiasm we agreed to go into full-scale production without benefit of the pilot-plant stage of development.

Raw materials used contained a higher percentage of fines than anticipated and these fines came out of the extractors with the solvent in spite of our best efforts to prevent it. After filtration, these tailings contained such a large percentage of valuable material that the economics of the process turned into a bright, bright, red.

So . . . "Let's drum the material and carry it in inventory until we find out how to process it." To make a long story short, this material was accumulating at a pretty fast clip and the day of reckoning was not far off.

Then . . . we had a fire. This material was all stored in and around the warehouse that burned and was completely ruined by both fire and water damage. I not only wouldn't like to count on that ever happening again, I shudder to even contemplate it.

▶**Is Honesty Best?**—As you can see, there are a lot of angles to the inventory problem. It's definitely a serious mistake to ever succumb to the temptation to misrepresent inventory figures.

At best you are concealing information that's of value to the company not only because of economic but also for technical reasons.

At worst, if you have a fire or other disaster you have placed your company in a very poor position in regard to recovery of insured loss. If you have been carrying an unreported inventory, the value of this is lost unless you revise your inventory figures after the fire; a procedure that would certainly be questioned by the insurance company.

If you have been reporting an inventory greater than your actual physical inventory you are subjecting your company to the possibility of charges of fraud.

The old slogan "Honesty is the best policy" is still true. Of course you may be fired but then you may be fired anyway.

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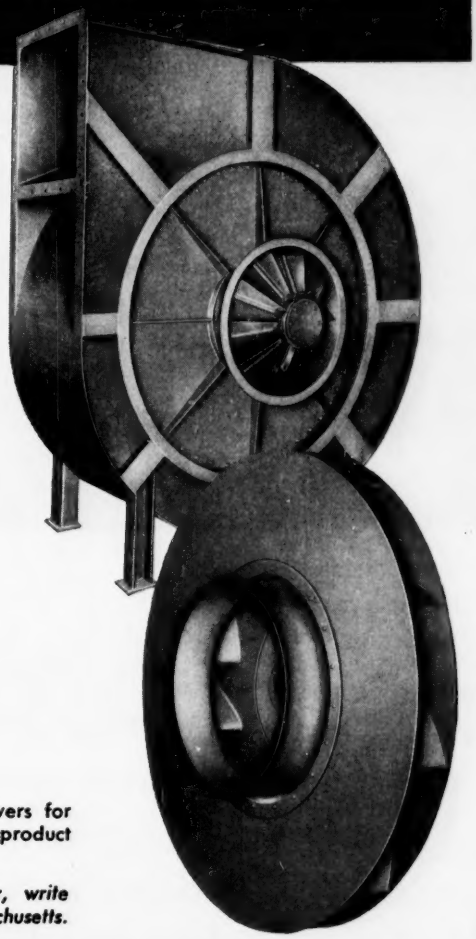

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Electric Current Ends Process Corrosion

A major, new tool for corrosion control: anodic metal passivation via impressed currents. Conoco has developed practical electric controllers which eliminate equipment corrosion.

For the first time passivation of process equipment against corrosion, by impressed current, is practical through development of a new, automatic electrical control system, called Anotrol.

Continental Oil, Ponca City, Okla., has successfully applied the method to corrosion control in a sulfonate plant. Attack of steel and stainless has been virtually eliminated on large-scale equipment and product quality improved—all at very low operating costs.

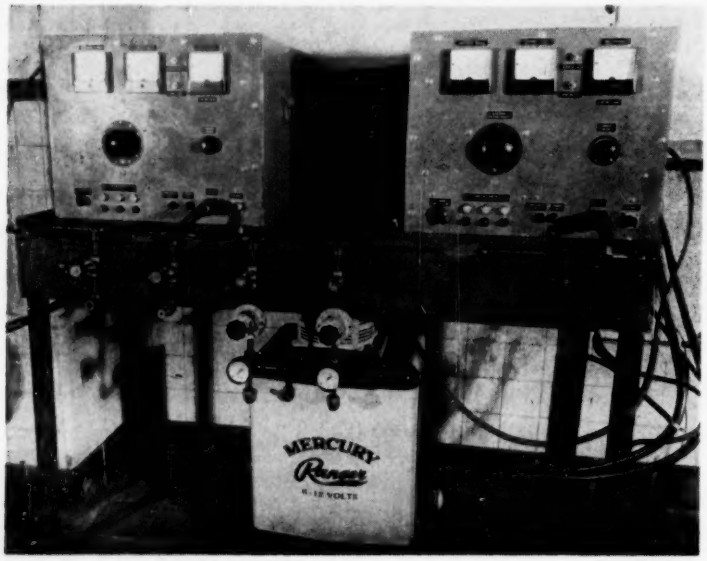
Conoco has applied for patents on the technique, will license process and equipment to users and act as consultants. Patents cover an electronic and electrode system capable of very precise current control.

Each different corrosion problem or piece of equipment requires a separate controller. And controllers, including installation, cost between $50 and $5,000, depending on complexity of the installation.

Most of Conoco's work has been on 67% H_2SO_4. But based on their data, Conoco engineers believe anodic passivity (building up a metal oxide film) can be established for a broad range of oxidizing environments, including phosphoric acid, nitric acid, sodium hydroxide, lithium hydroxide, ammonium nitrate, aluminum sulfate.

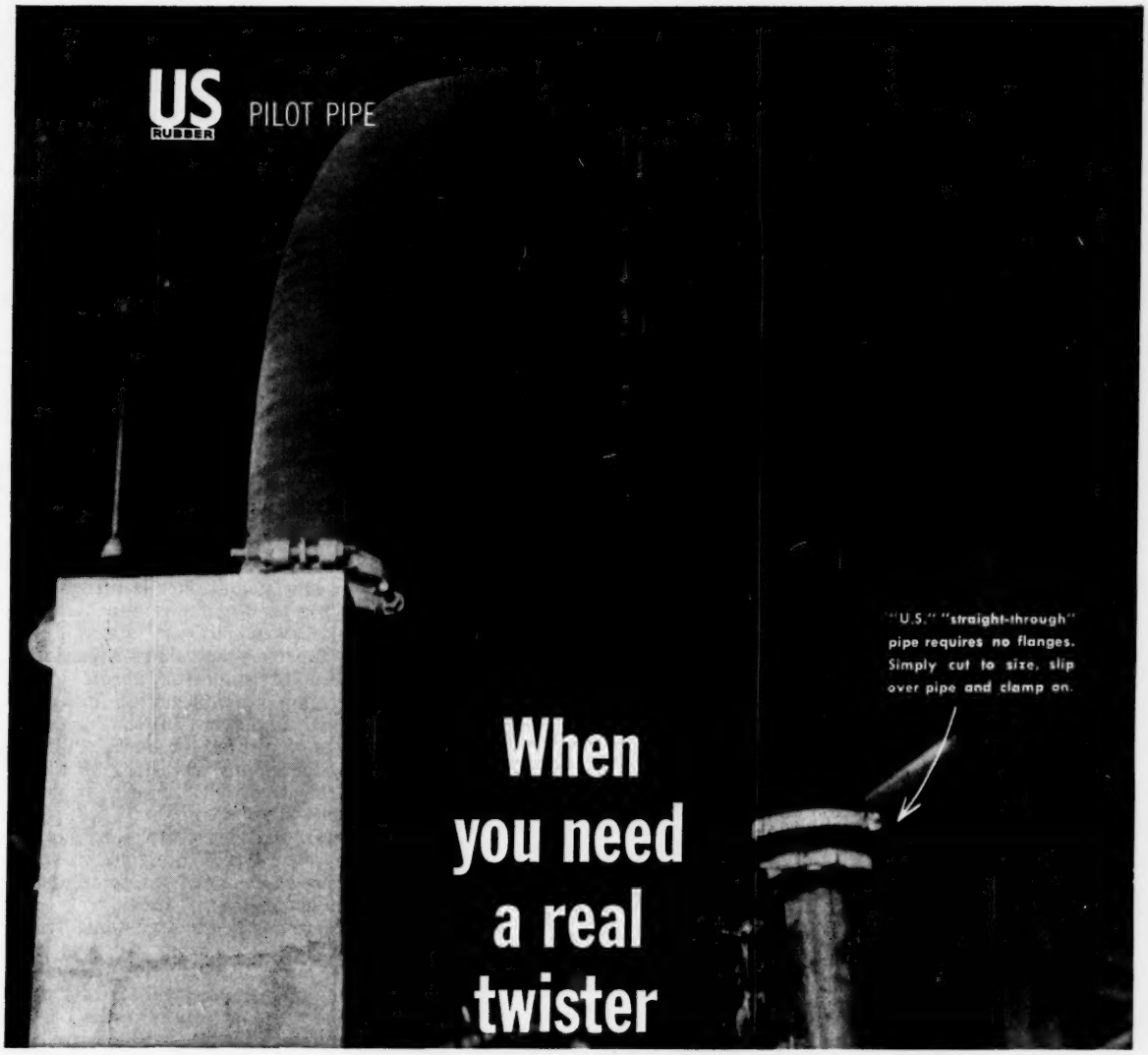
▶ **Make Metal Passive**—There's no complete agreement as to just what passivates metal—although the oxide theory is highly regarded. Many metals are "passivated" by alloying agents which reinforce the oxide film on the metal surface. Conoco uses an electric current to set up and maintain passivity* — particularly valuable in systems where the metal's natural passivity breaks down due to unfavorable kinetics of the corrosion reaction, or where metal never reaches the passive state on its own.

When a metal is immersed in an electrolyte, and current increased between the metal and a cathode, voltage potential will decrease as the corrosion rate goes up, to a certain point called the Flade peak. Then current drops to a low value, the voltage potential reverses itself and becomes increasingly cathodic, while current remains low over a fairly wide voltage variation.



AUTOMATIC ELECTRIC potential controller converts a.c. to d.c., is capable of delivering several hundred amp. to keep metal equipment "passive."

* Not to be confused with cathodic protection which counterbalances corrosive current with an impressed current. Conoco's anodic method increases corrosion current, building up a protective oxide film. Technique, which is well known, was previously only successful in the laboratory because of precise current control required.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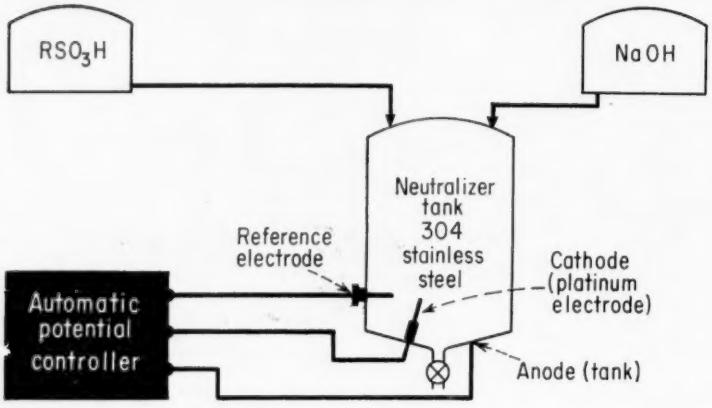
Stainless Steel Passivated by Anodic Control



This is the passive range, where an oxide film has formed. Then amperage rises again for increasing voltage, as the system goes into a transpassive region.

▶ **Lab Curves**—Not every metal-electrolyte system goes through these changes. So anodic passivation curves must be determined in the laboratory. Curves are developed by immersing metal in the plant corrosive, passing current through the system and taking voltage readings.

Voltage is plotted on the vertical axis, current on the horizontal axis. This, then, establishes if passivation is possible, and what current and voltage are necessary. Laboratory data are directly extrapolated to field installations (throwing power of the electrochemical cell seems to be extremely good).

In plant operation, the controller (essentially a potentiometer) supplies current of any required amount up to several hundred amperes to get to the passive range, and then delivers current needed to precisely maintain the laboratory-determined passive voltage (as called for by a reference electrode).

Vessel or equipment acts as the anode; cathode is a platinum electrode inserted in the equipment; reference electrode is saturated calomel or silver chloride. Current flow between reference and anode signals the controller to alter current flow between anode and cathode.

▶ **Critical Control**—So there are three critical points of control:

- Initial current.
- Voltage range in the passive area.
- Current required to maintain a passive film.

Conoco has found that a large current is required to reach a passive state quickly, but small currents will passivate if a longer time is allowed. For a 10,000 sq. in. surface, 80 amp. sets up passivity in about 20 sec., while 60 amp. called for 45 sec.

Also, it seems surface preparation is not a critical factor, although passivity is more slowly reached on dirty metal.

Design limitation on the voltage regulator is around 50 millivolts. This means the voltage spread in the passive range on the laboratory curves must be at least 50 millivolts, giving the controller a little time to make adjustments due to process variations. A voltage spread of 20 millivolts would indicate a very unstable passive film.

Film-maintenance current requirements are very important in determining economics of a system. Different metals call for different current densities. Type 316 stainless is more easily passivated and produces a more resistant film than other stainless steels. Mild steel is cheaper than stainless, but calls for more current and larger control equipment.

▶ **Sulfonation Plant** — At Conoco's Baltimore plant, the sulfonation units subjected to anodic control were a neutralization tank, an oleum storage tank and a oleum blowcase.

Conoco picked this equipment because they represented corrosion extremes. Oleum is mildly corrosive to mild steel (unless some water gets in by condensation). The 304 stainless neutralizer, where sulfonic acids* are neutralized with caustic soda, is subject to very severe pitting and extremes in pH.

Controller on the oleum tank works at all times until the blowcase fills up. Control is then switched to the blowcase until acid transfer is complete.

Neutralizer control begins as soon as the caustic covers the electrodes. At the end of each neutralization and removal of products, controller is turned off when the liquid level reaches the electrodes.

▶ **Downs Corrosion**—Effectiveness of automatic anodic protection was measured by (1) iron reduction in the process (2) improved product quality; reduction of emulsions in neutralizations (3) increase in productivity.

In the oleum tank and blowcase, iron concentration was reduced from 450 ppm. to 40 ppm. in about a year's time.

In the neutralizer tank, iron was reduced from 270 ppm. to 20 ppm. Previously, pitting of stainless steel called for tank repairs about seven times each month. Since the anodic installation a year ago, there hasn't been a single repair job.

▶ **Low Costs**—Operating costs for the neutralizer installation look like this:

- Average current density is 0.0043 amp./sq. ft.
- Watts = 6-v. source × 0.0043 = 0.0258 watts/sq. ft.
- Total watts = 400 sq. ft. × 0.0258 = 10.32×10^{-3} kw.
- Cost/day = 0.01032 × 24 × \$0.03 = \$0.0074/day to maintain passivity of 304 stainless in 67% H_2SO_4.

Of course, this doesn't include electrode replacement. Conoco believes reference electrode will be replaced after about a year at a cost of \$50.

Temperature has a pronounced

* Product of reaction between hydrocarbon such as dodecylbenzene and oleum.

from the makers of Dimetcote...

ZINKOTE®

THE FIRST 100% INORGANIC *SELF-CURING* ZINC COATING.

- A radically new concept in zinc coatings for protecting steel.
- Under development for many years and first patented in 1957.
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- Can be used wherever galvanizing is satisfactory – actually gives superior protection.
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- Insoluble in all petroleum products.
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- Applied by brush, spray or roller.
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How does Zinkote compare with Dimetcote? Although similar, each has certain unique advantages depending upon the particular requirements of the job. We will be glad to give you a specific recommendation.

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119

effect on stainless steel corrosion. So current density requirements for passivity increase as the temperature increases, but it's a gradual increase in most cases. And this isn't a serious problem: operating costs of the control system are negligible.

▶**Handles Complications**—Neutralization presents some complications, since a metal exposed to the system is subject to a range of corroding potentials. Separate polarization curves were first made for the acid and the base, and it turned out that a potential of about 100 millivolts put both in the passive region.

During the laboratory neutralization, the potential controller was set for 100 millivolts. Currents were recorded as the acid was added to the NaOH, and a plot of time vs. milliamp. showed typical peaks (Flade points). This data was used to design a plant controller for the neutralization tank.

Initial current to passivate the metal in 20% NaOH was 1.5 milliamp./sq. cm. Maintenance current to passivate was 300 microamps/sq. cm. When sulfonic acid was added, the current peaked at 1 milliamp./sq. cm. but receded to 30 microamp./sq. cm. in less than ½ sec.

▶**Severe Limitations** — Engineers are quick to point out five major limitations on Conoco's system:

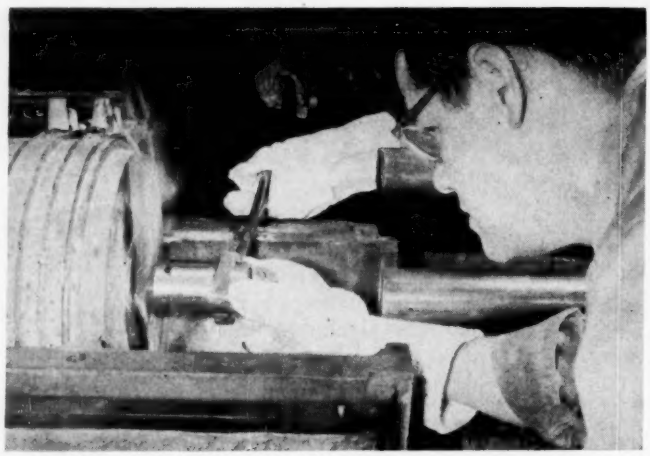
- Solution must be a good conductor.
- Metal-liquid system must be capable of anodic passivity.
- Halogens, which destroy passivity cannot be handled (except for small amounts of halogens).
- Reducing environments also cannot be handled.
- Copper-base metals can't be passivated by this system (ferrous metals, titanium, zirconium, can).

▶**What About Velocities?**—Two other considerations come up, which Conoco hasn't investigated thoroughly as yet. Flow conditions can be tolerated, since the passive film is quite stable, but more work is needed to define limits of fluid velocities in a passivated system. It is known that high-velocity streams can break down the natural resistance of stainless steels.

And there is also the problem of stress cracking, particularly in stainless steels. Some studies show that anodic polarization of metals can bring on cracking. Conoco hasn't found any cracking in 18-8 stainless anodically passivated, but recommends that anyone thinking of using the system where high stress levels are possible should thoroughly investigate it in the laboratory.

Additional details on the Conoco process were given at a recent South Central regional section meeting of the National Association of Corrosion Engineers (Denver, Colo., Oct. 14, 1959) in three papers:

1. Sudbury, J. D., Riggs, O. L., Shock, D. A., "Anodic Passivation Studies."
2. Riggs, O. L., Hutchison, M., Conger, N. L., "Anodic Control of Corrosion in a Sulfonation Plant."
3. Shock, D. A., Riggs, O. L., Sudbury, J. D., "Application of Anodic Corrosion Control in the Chemical Industry."



Ductile Chromium May Be Practical Soon

Tubing made of ductile chromium may not be too far off.

A big step in this direction: recent experimental extrusions of chromium tubing by Nuclear Metals, Inc. Previously, pure chromium rod and flat stock had been extruded—all hot ductile but brittle at room temperature.

Tube extrusion involves cold-compacting chromium powder into a mild-steel container. This is heated, placed in a 1,000-ton press and extruded over a mandrel.

Resulting chromium tubing is nearly perfect in form. Metal has a density close to the theoretical density of pure chromium.

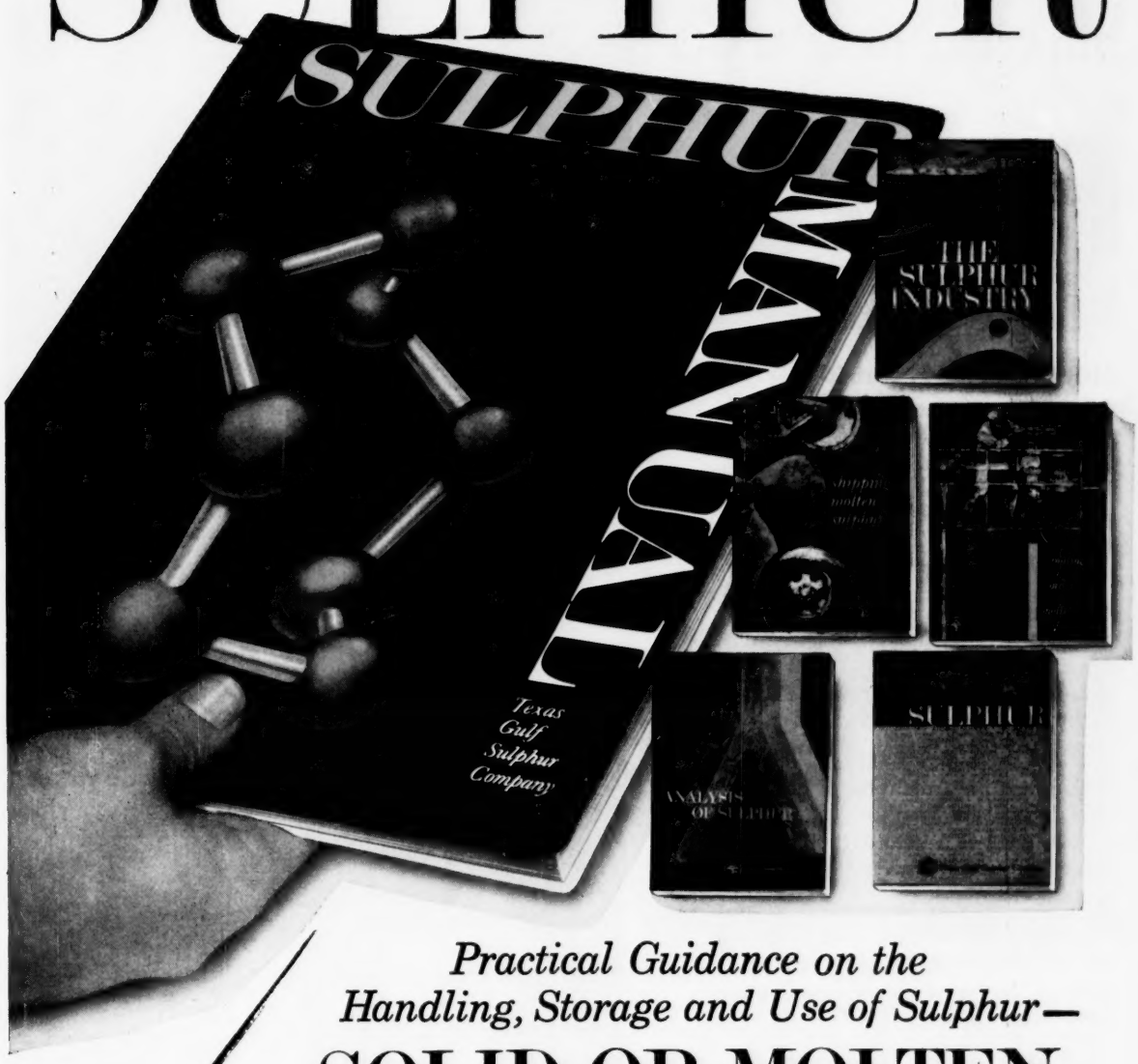
The process seems to be adaptable: a variety of tube sizes were made including 1-, 1.2-, and 1.4-in. o.d. with 0.06-, 0.07-, and 0.10-in. wall thicknesses.

Up until now chromium has been of interest primarily as a corrosion-resistant coating on metals or as an ingredient in stainless steels.

But ductile chromium could be a valuable structural material. Difficulty is that commercial chromium is extremely brittle at room temperatures. A ductile form would be highly resistant to corrosives and oxidation. Also, after alloying, it would have very good strengths at 2,000 F.

Union Carbide Metals—a prime chromium producer—looks to ductile sheet chromium as an excellent skin and structural material for aircraft and missiles. Tubing could go into jet and rocket exhaust systems.

SULPHUR



Practical Guidance on the Handling, Storage and Use of Sulphur—

SOLID OR MOLTEN

I — The Sulphur Industry
II — Shipping Molten Sulphur
III — Handling and Storage of Molten Sulphur
IV — Analysis of Sulphur
Appendix — Physico-Chemical Properties of Sulphur

Old hands, accustomed for years to handling Solid Sulphur, will need little advice, if any...unless Molten Sulphur is to be in the picture for the first time. In this case, our experience with and knowledge of Molten Sulphur may be helpful.

But new plants entering the Sulphur-consuming picture for the first time should find our service of considerable help regardless of the kind of Sulphur used. One facet of this service consists of a well-documented and well-illustrated 5 section Manual covering all phases of the handling, storage and use of Sulphur, both solid and molten, plus useful information on sampling, analyzing, and broad properties of Sulphur.

As a preliminary to any service in person you may require—and which we shall be glad to provide—would you like to have a copy of this Manual? Please write us on your company's letterhead and address your request to our Sales Department.

TEXAS GULF SULPHUR COMPANY

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Read about this amazing new AFCO

"Feutron"

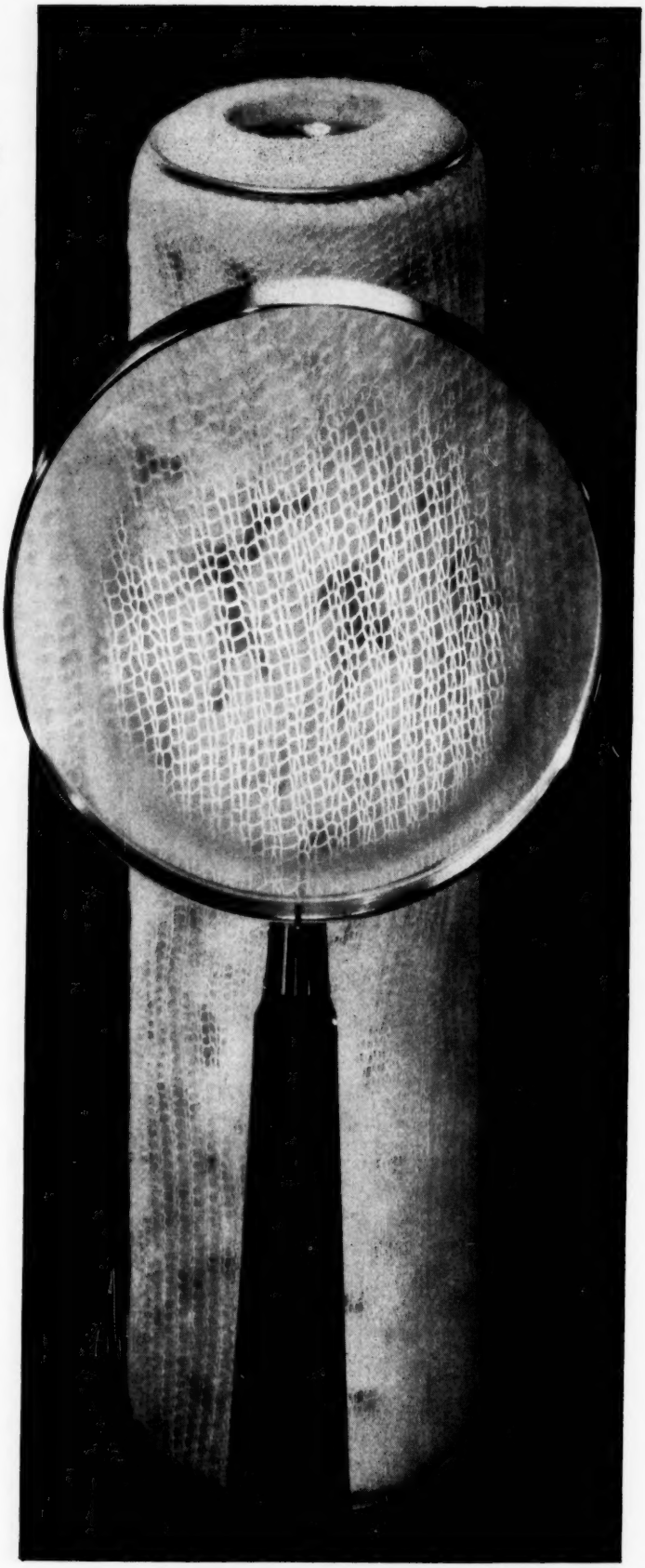
Filter Cartridge

Here's Why It Lasts Up To 600% Longer The superbly efficient AFCO "Feutron" filter cartridge is the product of a team effort: designed and engineered by American Felt Company . . . fibers by American Viscose.

To meet the challenging requirements of this new design our Research Laboratories engineered a completely new series of Avisco® rayon fibers. Their diameter is precisely controlled throughout the micron range . . . as is their weight, surface character and length.

This unique combination of cartridge design and fiber control permits the construction of filters with consistent cartridge density and predictable economic performance.

We are proud to have been selected by American Felt Company to participate in this most recent contribution to filtration progress.



AVISCO®

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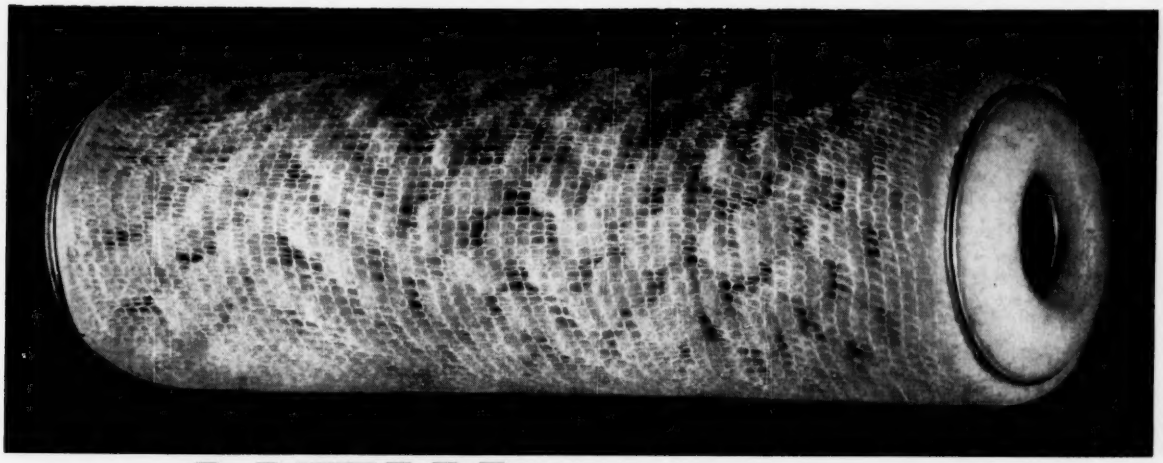
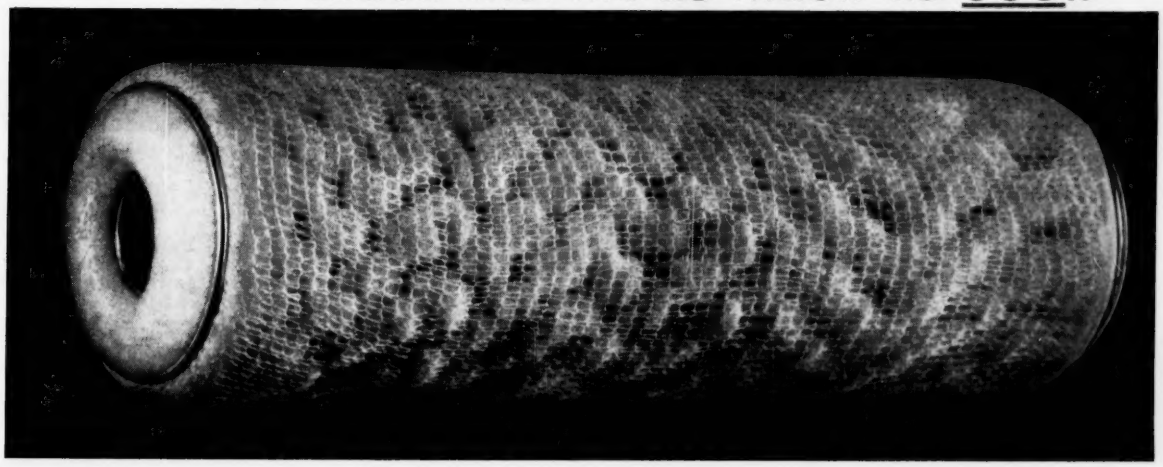


this NEW cartridge has increased filter life as much as 600%



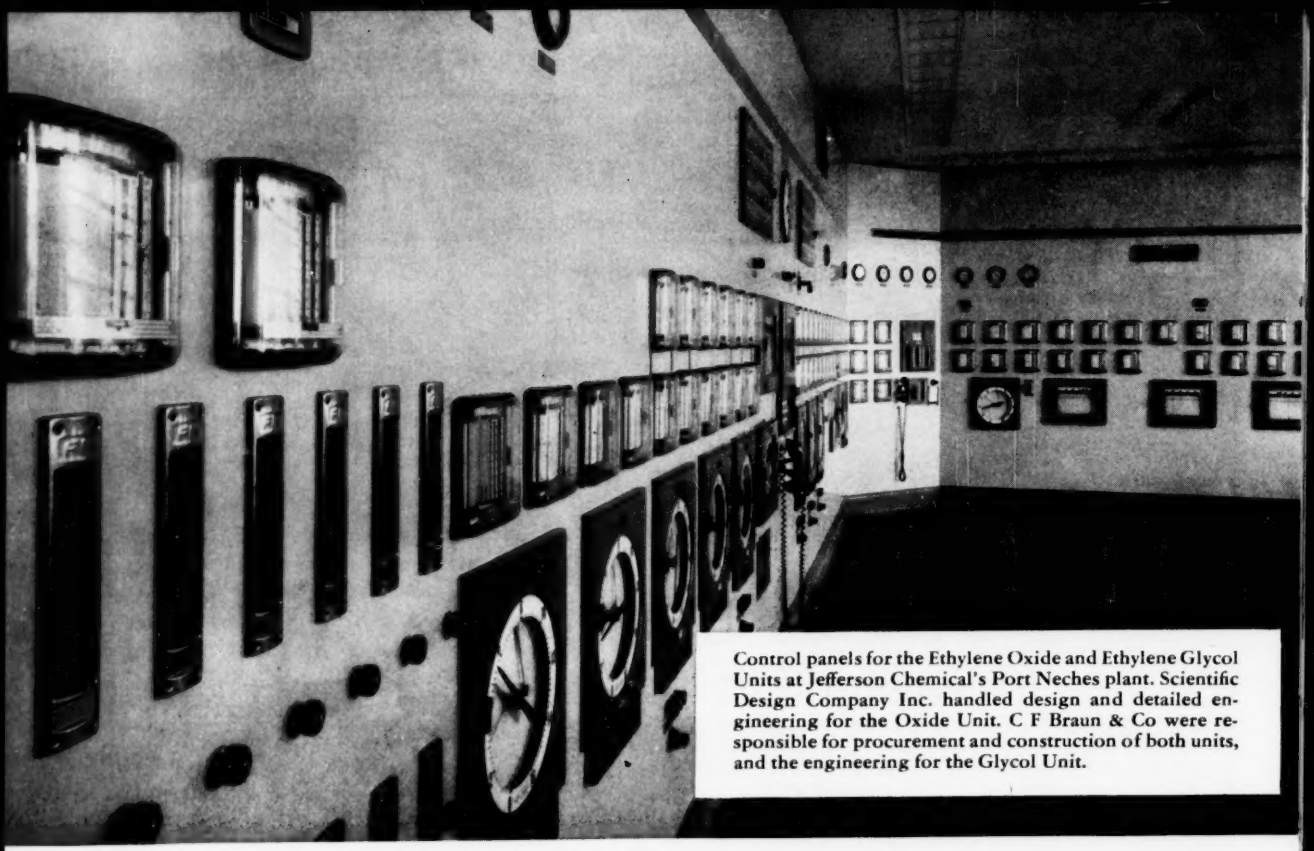
In actual production runs, this cartridge shows results like these: "Filtering capacity increased from 100 gallons to 300 gallons" . . . "filter life extended from 1000 gallons to 2000 gallons" . . . "outperforms others 4 to 1" . . . "capacity increased from 800 gallons to 5200 gallons."

The reason: a new filtration principle. The AFCO cartridge is constructed of new, chemically pure fibers of selected diameter. It is the unique construction of the "Feutron" filter media which uses these custom-engineered fibers that assures precision filtration throughout the micron range.

The result: increased solids capacity, lower pressure (which permits a higher filtrate rate), and more uniform performance.

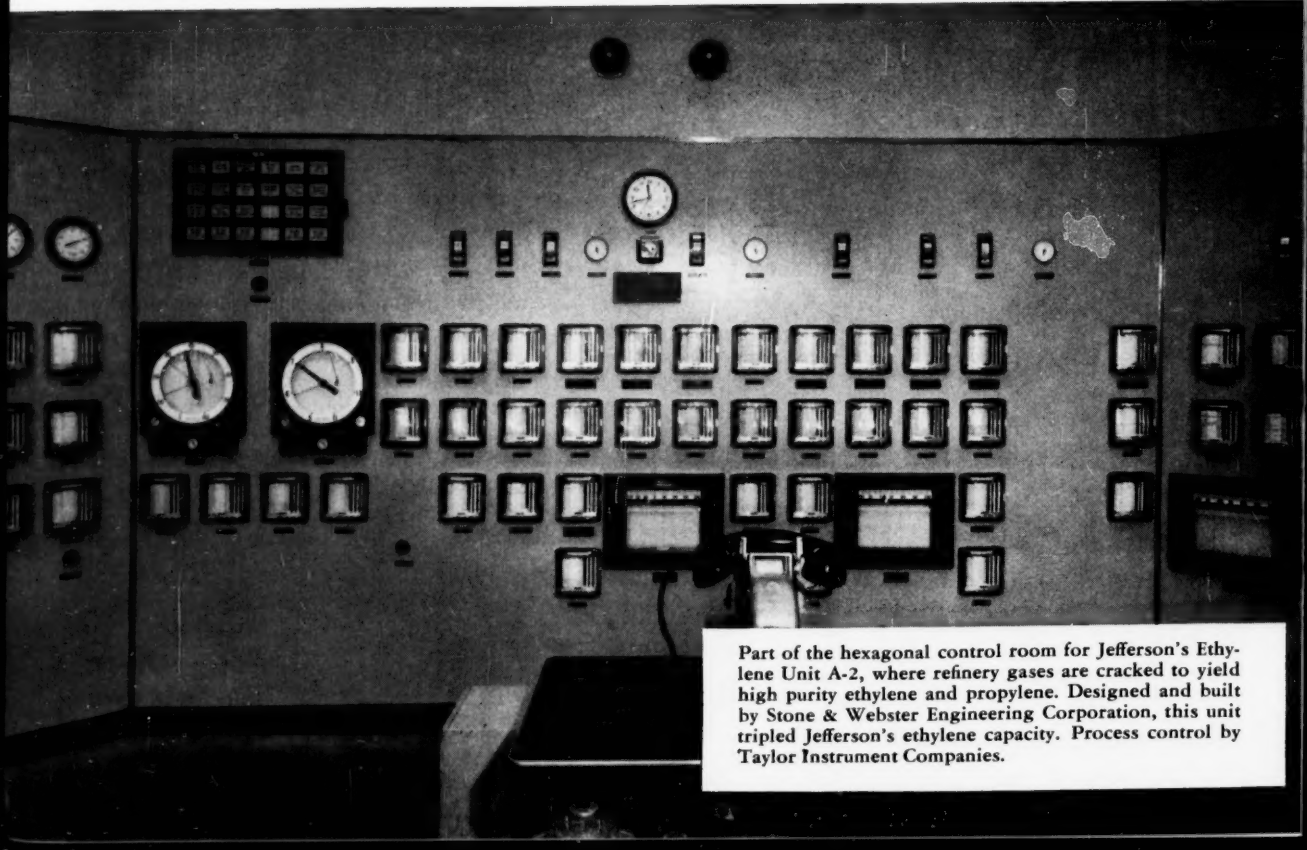
The AFCO "Feutron" filter cartridge is sold *direct*. You deal *direct* with American Felt Company and are in personal contact with our engineering and research laboratories. *Write for full details today.*

AMERICAN FELT COMPANY
513 Glenville Road
Glenville, Connecticut
OVER 60 YEARS OF FILTRATION EXPERIENCE



Control panels for the Ethylene Oxide and Ethylene Glycol Units at Jefferson Chemical's Port Neches plant. Scientific Design Company Inc. handled design and detailed engineering for the Oxide Unit. C F Braun & Co were responsible for procurement and construction of both units, and the engineering for the Glycol Unit.

JEFFERSON CHEMICAL RE-ORDERED



Part of the hexagonal control room for Jefferson's Ethylene Unit A-2, where refinery gases are cracked to yield high purity ethylene and propylene. Designed and built by Stone & Webster Engineering Corporation, this unit tripled Jefferson's ethylene capacity. Process control by Taylor Instrument Companies.

HERE'S WHY:

"Smoothest unit start-ups ever experienced"

"A very minimum amount of
instrument trouble was experienced"

"Instrument maintenance is at an all-time low"

"Transcope line of instruments
is as versatile as we have ever used"

"Dollar for Dollar value, Transcope instruments
are one of the most advanced designs offered today"

TAYLOR TRANSCOPE* INSTRUMENTS

The statements above, and many other equally complimentary comments, were made by the Instrument Engineer at Jefferson Chemical Co., Inc., Mr. J. W. Rutledge. He's referring to the performance of TRANSCOPE instrumentation at the Port Neches plant, first on the Ethylene Unit A-2 and later on the Ethylene Oxide and Ethylene Glycol Units.

In Mr. Rutledge's own words: "The new Taylor TRANSCOPE instruments were purchased for subsequent expansion, due to the fine performance of these instruments on our previous unit start-ups and the smooth operation of the operating units, as well as the low initial cost".

The photographs at left show a few of the several hundred TRANSCOPE Plug-in Recorders in use at Port Neches. In addition, Jefferson Chemical use many TRANSCOPE Indicators and Controllers and TRANSAIRE* Temperature Transmitters.

"Never before so many features in so little panel space", has been our claim for the 90J Transcope Recorder since first introduced. The experience of Jefferson Chemical, and of many other companies in the chemical, petroleum and petro-chemical field all over the world is, we believe, eloquent "proof of the pudding".

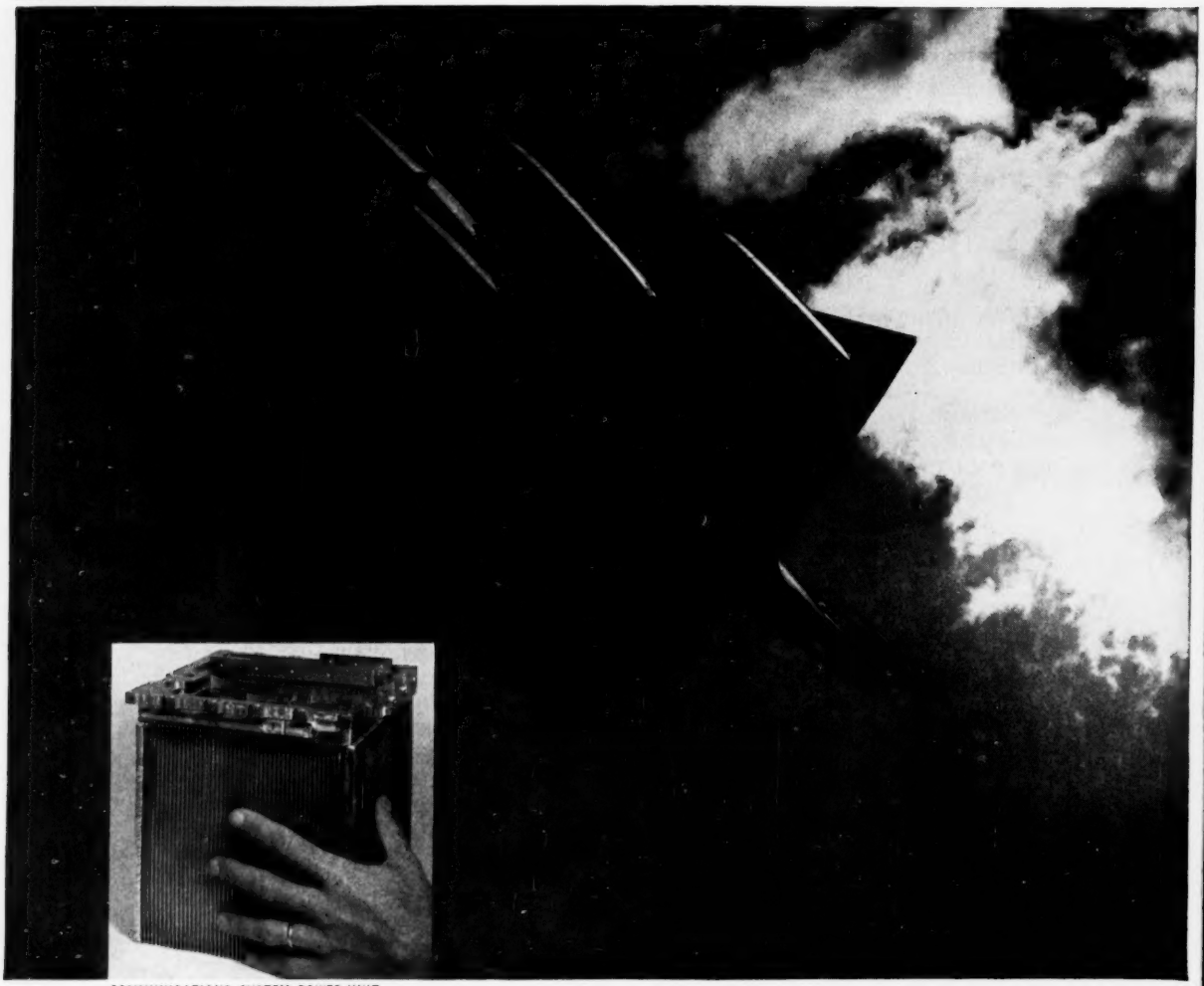
To learn more about the truly remarkable—and many unique—features of the TRANSCOPE instruments, call your Taylor Field Engineer; or write for **Bulletin 98286.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ont.

*Reg. U.S. Pat. Off.

Taylor Instruments **MEAN ACCURACY FIRST**

3M COMPANY CHEMICALS

THE RAW MATERIALS OF PROGRESS



COMMUNICATIONS SYSTEM POWER UNIT

POWER...IN THE SPAN OF A MAN'S HAND...

This remarkably small 1 KW linear power amplifier (entire unit is approximately the size of an 8½" cube) was developed by the Communications Division of Hughes Aircraft for the U. S. Air Force B-58 bomber.

With a blend of 3M Company's FC-75 and FC-43 as a dielectric coolant, the amplifier provides all the high-power output required by this huge aircraft's HF communications system, yet withstands all military environments at temperatures from —55°F. to +200°F. Here's why: the circuitry of the amplifier is immersed in this non-corrosive, non-flammable inert fluid which protects it against internally generated heat through a highly efficient evaporative cooling process. There are no hot spots, and a uniform temperature is maintained throughout.

By using FC-75 and FC-43 in this way, Hughes Communications Division engineers were able to achieve a "compression in volume of a factor of 6" when developing this amplifier for use in an area where space is at a premium. Other areas of application now under investigation include submarines and ground base systems.

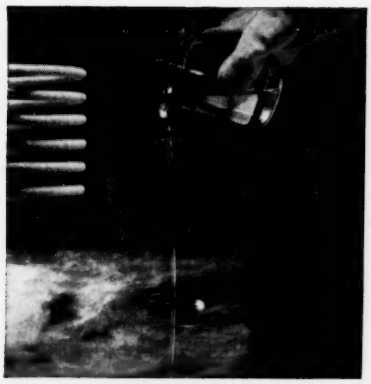
Why not investigate the remarkable properties of 3M Inert Fluids in terms of your product design, miniaturization or performance problems? For complete data, write: 3M Chemical Division, Dept. KAL-119, St. Paul 6, Minn.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY



THERMAL AND CHEMICAL STABILITY as well as dielectric properties make 3M Brand Fluorochemical FC-75 and FC-43 right for use in the Hughes Power Amplifier. FC-75 has a useful liquid range of —150°F. to +212°F. at atmospheric pressure, with a viscosity of 16 Centistokes at —90°F. In addition, it offers these other useful properties: high dielectric strength in both liquid and vapor state (37 KV 0.1" gap for liquid) . . . self-healing in high voltage electrical equipment . . . excellent wetting power . . . compatible with materials commonly used in the construction of high temperature equipment . . . thermally stable to temperatures in excess of 750°F. and, even under extreme use conditions, does not form sludge or corrosive products. Heat capacities in liquid and vapor state are approximately equal.

FC-75 COOLED!

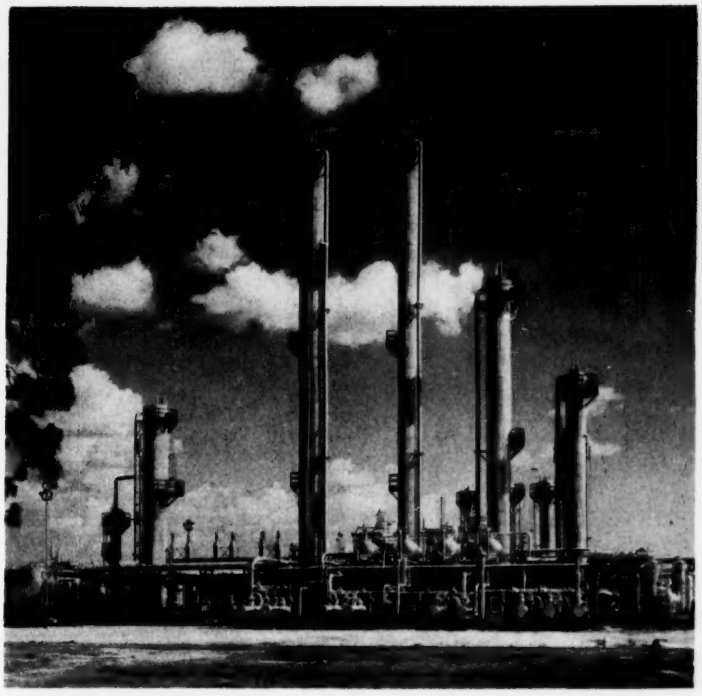
3M CHEMICAL DIVISION, MANUFACTURERS OF:

- **ACIDS**
- **RESINS**
- **ELASTOMERS**
- **PLASTICS**
- **OILS, WAXES AND GREASES**
- **DISPERSION COATINGS**
- **FUNCTIONAL FLUOROCHEMICALS**
- **SURFACTANTS**
- **AND INERT LIQUIDS**

FIRMS IN THE NEWS

J. A. KING

NEW FACILITIES



Texas Refinery, Soon to Produce More Middle Distillates

Shell Oil Co. reveals plans for a $1-million expansion of its Sheridan Refinery, located near Houston, Tex. Addition of new field gathering lines, absorption and refrigeration equipment will increase plant throughput from 110- to 130-million cu. ft./day of gas. Thus will present production of 5,000 bbl./day of propane, isobutane, butane, isopentene, natural gasoline and other liquid products be considerably increased. Construction, to begin early next year, is scheduled for completion by next fall.

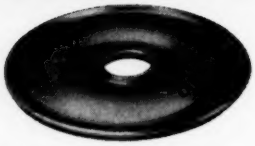
Humble Oil & Refining Co. reveals plans for construction of a new lube-oil processing plant and expansion of two lube-oil units at its Baytown, Tex., refinery. New unit will be a 9,500-bbl./day lube hydrofiner; units to be expanded are for lube-dewaxing and lube-extraction. Construction is scheduled for completion by late-1960.

Texas Industries, Inc. announces plans for construction of a 1.4-million-bbl./yr. cement plant at Midlothian, Tex. Construction of new facility, to cost $14-million, is scheduled to begin next month.

Tidewater Oil Co. is constructing a $1.5-million natural gasoline plant near Houma, La., to process 75-million cu. ft./day of separator gas residue. Low-temperature absorption at 0 F. and 1,030 psi. will recover 1,030 bbl./day of propane, butane and natural

Pencil test demonstrates how the DURABLA valve member tilts and opens easily, without noticeable friction. Compare this with any other pump valve.

NO. 1 REASON



this is the ideal valve for high-speed pumps

Key to the high efficiency and free action of a DURABLA V-7* Pump Valve Unit is the patented lightweight valve member. Making only "point contact" on the sleeve, it can't bind or hang up. Nor can it warp, thanks to its unique arched design.

This low-lift valve member is designed to open with a tilt, following the flow lines. Valve action is very sharp, thanks to lightness and flexibility. That's why DURABLA is the only valve ideally suited to high-speed operation.

DURABLA valve units operate freely under temperature-pressure extremes, with corrosive fluids and in any position. Available in 17 sizes, they will meet over 300 variations in installation requirements.

Send for booklet CE-119.

DURABLA MANUFACTURING COMPANY

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DM-35

*Patent applied for

DURABLA®

Manufacturers of DURABLA sheet packing, gaskets and check valves

gasoline from lease separator gas. Construction is scheduled for completion by late-1960.

Borden Chemical Co. will soon begin construction of a 47,500-ton/yr. resin and formaldehyde plant near San Francisco, Calif. Breakdown of output will be: 25,000 tons/yr. of resin and 22,500 tons/yr. of formaldehyde for adhesive and paint manufacture. Construction will begin late this year.

Imperial Oil, Ltd. placed on stream its new 14,700-bbl./day refinery at Calgary, Alta., last month. New $14-million facility includes a catalytic cracker and powerformer units for manufacture of high-octane gasoline.

Dupont announces plans for construction of a new methylamine plant at Belle, W. Va., to more than double its capacity for methylamines, now produced at Houston, Tex. This intermediate is now used in rocket-propellant, textile-fiber, dye, rubber and pharmaceutical manufacture.

Tennessee Gas Transmission Co. has completed construction of a natural-gas processing plant near Rockport, Tex., to process 50-million cu. ft./day of gas. Bay Petroleum Co., a division of Tennessee Gas, will operate the plant, will produce 45,000 gal./day of propane, butane, isobutane and natural gasoline.

Goodyear Tire & Rubber Co. is now increasing its Vitafilm production capacity at its Akron, Ohio, plant. Vitafilm is an industrial wrapping and packaging material; recent FDA approval of Vitafilm for food wrapping spurred Goodyear to expand its capacity by 50%.

Crown Zellerbach Corp. announces plans for construction of a 2,500-ton/yr. dimethyl sulfoxide plant in Bogalusa, La. This water-white solvant is widely used in spinning of acrylonitrile

fibers, is produced by oxidation of dimethyl sulfide.

British American Oil Co. has completed another expansion of its Pincher Creek, Alta., gas-processing plant. This third in several stages of construction, costing a total of $29-million, enables British American to process 196-million cu. ft./day of natural gas. Plant now has capacity to recover 24,500 gal./day of propane, 31,400 gal./day of butane and 690 long tons/day of sulfur.

Pittsburgh Coke & Chemical Co. will build a 1,000-ton/day maleic anhydride plant at its Neville Island, Pa., facility. New plant, to go on stream early in 1961, will supply maleic anhydride to the plastics industry.

Monsanto Chemical Co. reveals plans to expand in the Oxnard, Calif., area, has acquired option to purchase a 450-acre industrial tract there, but declines to disclose plans for the new site.

Dow Chemical Co. will add another to its trio of styrene-butadiene latex plants, this one to be built at Allyn Point, Conn. New plant, to be built by early 1961, will meet growing demands by paint, paper, textile and building product producers in the New England area.

Purolator Products, Inc., has formed two foreign divisions to market its filters: Purolator Products A. G., Zug, Switzerland and Purolator Inter-America Corp. to cover the Mexican, Caribbean, Central and South American territories.

Courtalds, Ltd. has formed two new companies on this conti-

NEW

ULTRASONIC THICKNESS GAGE

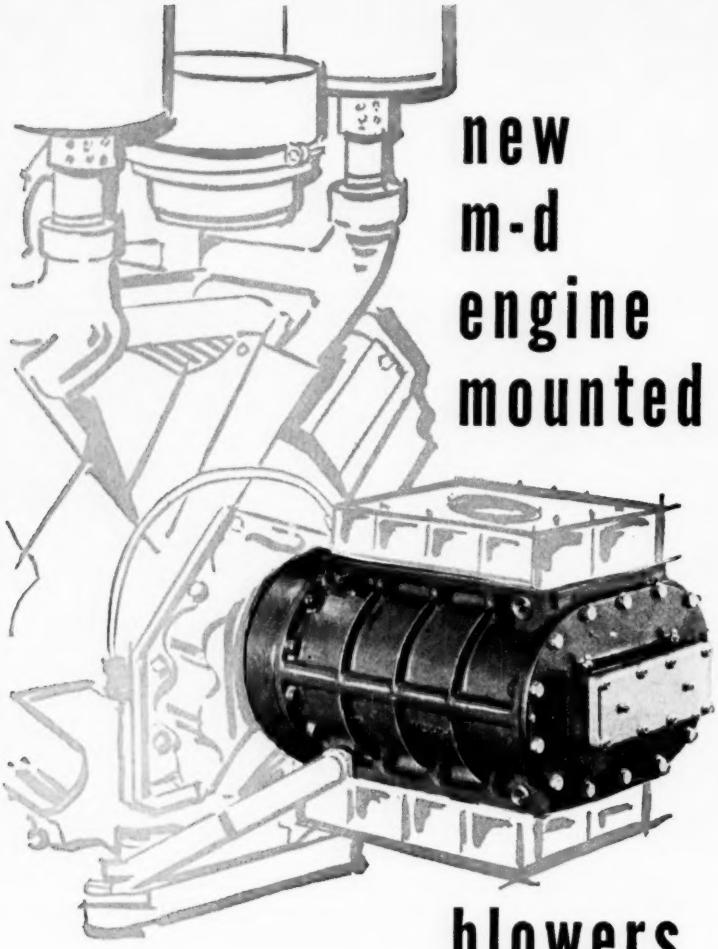
Now you can measure wall thickness accurately with Sperry's new direct reading ultrasonic thickness gage. Battery-operated, it is small and light enough (10 lbs.) to be carried anywhere — to inspect ship hull plates, bulkheads, storage vessels, high pressure pipe.

Using the pulse echo method, this new Sperry thickness gage works even where surfaces are not parallel or where they are corroded and rough. Easy-to-read meter is directly calibrated in inches, and alarm lamps are provided for go-no-go operation or when testing in dark areas.

There is a full line of ultrasonic inspection instruments available from Sperry, for fourteen years leading designers and engineers of ultrasonic testing equipment and SIMAC automated inspection systems.

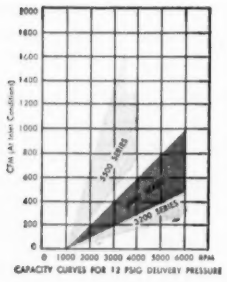
Write for descriptive literature.

Sperry Products Company
a division of Howe Sound Company
Danbury, Connecticut



new m-d engine mounted blowers

weigh only 625 lbs. Provide 400 SCFM continuous air flow



CAPACITY CURVES FOR 12 PSIG DELIVERY PRESSURE

M-D answers the need for lightweight pneumatic units for vacuum or high pressure systems. Only 625 lbs. total weight of blower *and* engine. Dependable M-D units generate 15 PSIG of continuous air flow or up to 18 PSIG in surges. Ideal for mobile applications. M-D muffler packs mean quiet operation.

M-D blowers operate at wider pressure and speed ranges than any other rotary positive blower. Capacities of 22 production models range from 50 to 4,000 CFM, pressures to 15 PSIG single, 70 PSIG multi-stage.

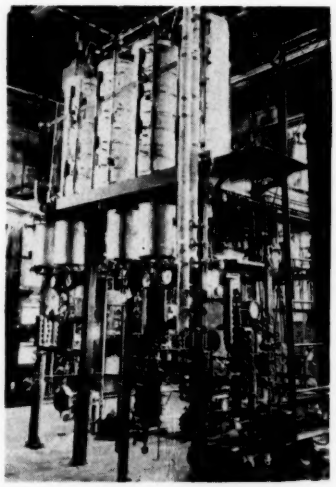
For full information write

M-D BLOWERS, INC., RACINE, WISCONSIN

A SUBSIDIARY OF MIEHLE-GOSS-DEXTER, INC.

FIRMS . . .

nent to broaden its activities here: Courtalds North America, Inc., New York, N. Y. and Courtalds North America, Ltd., Montreal, Que. Courtalds is a world-wide producer of synthetic fibers, chemicals, packaging films, plastics, paint and pulp.



M. W. Kellogg Co., New York, N. Y., announces that it now offers research and development services on a contract basis. Pilot unit, shown above, is one of several, now used in contract process development.

American Meter Co. has acquired the Granberg Corp. of Oakland, Calif. American Meter manufactures pumps, meters, valves, regulators, laboratory and testing apparatus; Greenberg manufactures tank-truck, bulk-plant and pipeline meters and pumps.

Controls Co. of America have formed a new subsidiary, Solid State Electronics Controls, Inc., with plant and headquarters at Tempe, Ariz. New company will develop and manufacture silicon solar converters, semiconductor rectifiers and diodes and other solid-state devices.

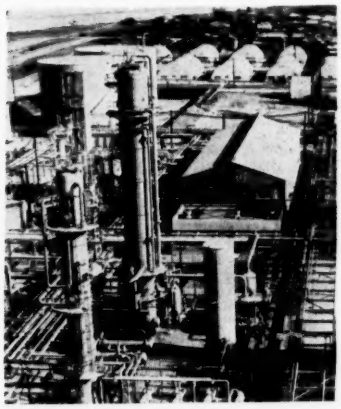
Flintkote Co. has acquired the Calaveras Cement Co., another in a series of 111 acquisitions in the last three years.

Flintkote has doubled its sales from $100 to 200-million and has expanded its output from a single product, asphalt roofing, to a complete line of building materials from flooring to roofing.

OVERSEAS BRIEFS

Ghana: Associated Portland Cement Co. is now investigating the Bonyeri area of Ghana with a view to construction of a $12-million cement plant there. Planned large-scale industrialization of Ghana will soon demand huge cement supplies (*Chem. Eng.*, Nov. 2, p. 128).

Trinidad: Texaco announces plans for an $18-million expansion of its refinery at Point-a-Pierre. Addition of new topping, catalytic reforming, hydrotreating, pipeline, tankage and jetting facilities will up output by 100,000 bbl./day to 235,000 bbl./day.



Korea: Soon to begin operation is the $40-million urea plant at Chung-Ju, S. Korea, shown above. Urea unit, with 270-ton/day capacity, will use the Inventa-Vulcan process (*Chem. Eng.*, Jan. 26, pp. 78-81) was engineered by Vulcan-Cincinnati, Inc., of Cincinnati, Ohio.

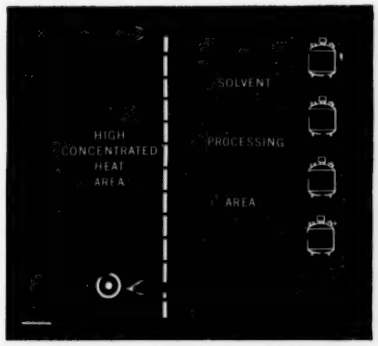
AROCLOR SYSTEMS DELIVER STEADY PROCESS HEAT TO 600°F and . . .

PINPOINT HEAT CONTROL . . .

to within 2° F. Indirect heating with Aroclor 1248 ends processing problems from local hot spots and overheating. Units range from small, portable electric types to large, gas- and oil-fired heaters generating up to 20,000,000 BTU's per hour. Typical uses: cooking of alkyd resins, dyestuff synthesis and other chemical reactions, deep-fat frying and other food processing, drying ovens and molding equipment.

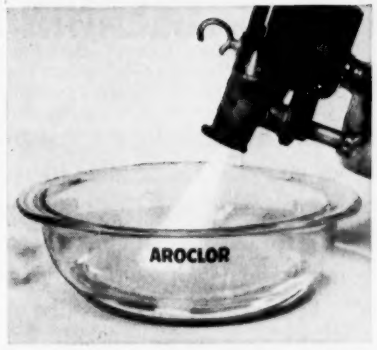
ECONOMY!

Unpressurized systems cost less to install and maintain than pressurized systems. Forced circulation of liquid Aroclor requires no condensers, vaporizers, traps, heavy-walled jackets or complex feed mechanisms. Compact design saves space. Heat from a single unit can be supplied for multiple uses at different temperatures. Total efficiency saves processing dollars.



FIRE SAFETY!

Even a blowtorch won't ignite fire-safe Aroclor 1248. A heating system designed with Aroclor 1248 eliminates the hazard of the vaporized, flammable fluid or danger of direct flame processing. Operating in a closed system vented to the atmosphere, these heating systems also eliminate the threat of "live" steam or chemical vapors escaping under pressure.



46 firms now design or manufacture Aroclor heating systems and components. Write or use coupon for guide to selecting the best system for your application.

Monsanto Chemical Company
Organic Chemicals Division
Dept. IF-4, St. Louis 66, Mo.

Please send information booklet on Aroclor 1248 heating systems and guide to heater selection.

*Name*_____
*Company*_____
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AMCHEM PRODUCTS, INC., AMBLER 49, PA.

Please send me "Data File" and Selection Chart describing uses of Rodine Inhibitors for Industrial cleaning.

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COMPANY.....

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CITY..... ZONE..... STATE.....

CLIP THIS COUPON . . .

for **SELECTION CHART** on Rodine Acid Inhibitors for **INDUSTRIAL CLEANING!**

Now—available for the first time—a handy selection guide to let you easily determine the proper class of inhibitors to use for various metals and cleaning media!

Rodine Acid Inhibitors are ideal for all types of specialized industrial cleaning requirements. Rodine effectively inhibits acid solvents used to dissolve deposits in industrial equipment, tanks, and piping systems. Find out how Rodine can protect your investment in costly equipment by eliminating acid erosion.

Get all the facts . . . **TODAY!** AMCHEM

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CALENDAR

Exposition of Chemical Industries, New York Coliseum.
Nov. 30-Dec. 4 New York, N. Y.

National Council for Stream Improvement, North America Pulp, Paper and Paperboard, Industrial Waste Conference, Edgewater Beach Hotel.
Dec. 1-2 Chicago, Ill.

Eastern Joint Computer Conference, Statler-Hilton Hotel.
Dec. 1-3 Boston, Mass.

American Institute of Mining, Metallurgical and Petroleum Engineers, Metallurgical Society, annual conference of the Electric Furnace Committee-Iron and Steel Div., Cleveland Hotel.
Dec. 2-4 Cleveland, Ohio.

American Institute of Chemical Engineers, annual meeting, Sheraton Palace.
Dec. 6-9 San Francisco, Calif.

Chemical Specialties Manufacturers Assn., annual meeting, Mayflower Hotel.
Dec. 7-9 Washington, D. C.

American Medical Assn., clinical meeting, Dallas Auditorium.
Dec. 7-10 Dallas, Tex.

The Material Handling Institute, annual meeting, Savoy-Hilton Hotel.
Dec. 13-16 New York, N. Y.

American Statistical Assn., annual meeting, Shoreham Hotel.
Dec. 27-30 Washington, D. C.

American Chemical Society, Div. of Industrial and Engineering Chemistry, Christmas Symposium.
Dec. 28-29 Baltimore, Md.

Society of Plastics Engineers, annual technical conference, Conrad Hilton Hotel.
Jan. 12-15 Chicago, Ill.

Oil Trades Assn. of New York, Waldorf Astoria Hotel.
Jan. 20 New York, N. Y.

Engineers Joint Council, annual meeting, Engineering Building.
Jan. 22 New York, N. Y.

Plant Maintenance and Engineering Show, Convention Hall.
Jan. 25-28 Philadelphia, Pa.

American Society for Engineering Education, college-industry conference, Washington University.
Jan. 27-28 St. Louis, Mo.

American Physical Society, annual meeting, Hotel New Yorker.
Jan. 27-30 New York, N. Y.

American Rocket Society, Solids Propellants Conference, Princeton University.
Jan. 28-29 Princeton, N. J.

American Institute of Electrical Engineers, national meeting.
Jan. 31-Feb. 5 New York, N. Y.

Instrument Society of America, Instrument and Automation Conference and Exhibit, Sam Houston Coliseum.
Feb. 1-5 Houston, Tex.

American Society for Testing Materials, committee week, Sherman Hotel.
Feb. 1-5 Chicago, Ill.

Society of the Plastics Industry, Reinforced Plastics Div. meeting, Edgewater Beach Hotel.
Feb. 2-4 Chicago, Ill.

American Society for Metals, metals conference, Fairmont Hotel.
Feb. 4-6 San Francisco, Calif.

American Institute of Mining, Metallurgical and Petroleum Engineers, annual meeting, Statler McAlpin Hotel.
Feb. 14-18 New York, N. Y.

National Society of Professional Engineers, winter meeting, Broadview Hotel.
Feb. 18-20 Wichita, Kan.

American Institute of Chemical Engineers, national meeting, Biltmore Hotel.
Feb. 21-24 Atlanta, Ga.

Technical Assn. of the Pulp and Paper Industry, annual meeting, Commodore Hotel.
Feb. 22-25 New York, N. Y.

Natural Gas Engineering Conference, Oklahoma State University.
Feb. 23-25 Stillwater, Okla.

Pittsburgh Conference on Analytical Chemistry and Spectroscopy, Penn-Sheraton Hotel.
Feb. 29-Mar. 4 Pittsburgh, Pa.

American Society of Mechanical Engineers, Gas Turbine Power conference and exhibit, Rice Hotel.
Mar. 6-9 Houston, Tex.

American Society of Mechanical Engineers, Hydraulic Conference, Rice Hotel.
Mar. 6-9 Houston, Tex.

Instrument Society of America, Temperature Symposium, Deshler-Hilton Hotel.
Mar. 9-11 Columbus, Ohio

American Concrete Institute, annual convention, Commodore Hotel.
Mar. 14-17 New York, N. Y.

Institute of Radio Engineers, national convention, Waldorf Astoria Hotel & Coliseum.
Mar. 21-24 New York, N. Y.

Textile Research Institute, annual meeting, Hotel Commodore.
Mar. 24-25 New York, N. Y.

Nuclear Congress, sponsored by Engineers Joint Council and Engineering and Scientific Societies, Coliseum.
April 3-8 New York, N. Y.

American Society of Mechanical Engineers, Nuclear Engineering Div. conference, Coliseum and Statler Hotel.
April 4-8 New York, N. Y.

American Oil Chemists Society, meeting, Baker Hotel.
April 4-6 Dallas, Tex.

American Society of Mechanical Engineers-Institute of Radio Engineers-American Institute of Electrical Engineers, third annual conference on Automatic Techniques, Cleveland-Sheraton Hotel.
April 18-19 Cleveland, Ohio

American Society of Lubrication Engineers, annual meeting and exhibit, Netherland-Hilton Hotel.
April 19-21 Cincinnati, Ohio

FACTS You Should Know . . .

about the DIFFERENCE in Stainless Steel Tubing — —

Both photographs above show the microstructure of the weld and base metal of Type 304 stainless steel tubes. Photograph A reveals accelerated corrosion of the weld metal due to the presence of delta-ferrite. This tube was manufactured by welding, swaging and annealing, which is an insufficient amount of cold work to produce a high quality, uniformly corrosion-resistant welded tube.

Photograph B shows a typical tube supplied by Wallingford Steel. This tube was produced by the welding and cold drawing process, then inspected with a Magne Gauge to insure no ferrite was present in the weld metal. *Processed and inspected in this manner, Wallingford Cold Drawn Tube is guaranteed to show no preferential attack in weld area.*

All Wallingford welded stainless steel tubing is cold drawn and inspected by Magne Gauge. *Can your suppliers say this about the stainless steel tubing they produce?* Wallingford's manufacturing techniques and quality control checks assure top quality — *yet cost you no more.* Why not purchase *your* tubing where *tonnage is produced on a laboratory basis?*

Write for additional information to:
The Wallingford Steel Co., Wallingford, Connecticut.

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Progress in Metals for over 37 Years

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COLD ROLLED STRIP: *Super Metals, Stainless, Alloy*
WELDED TUBES AND PIPE: *Super Metals, Stainless, Alloy*

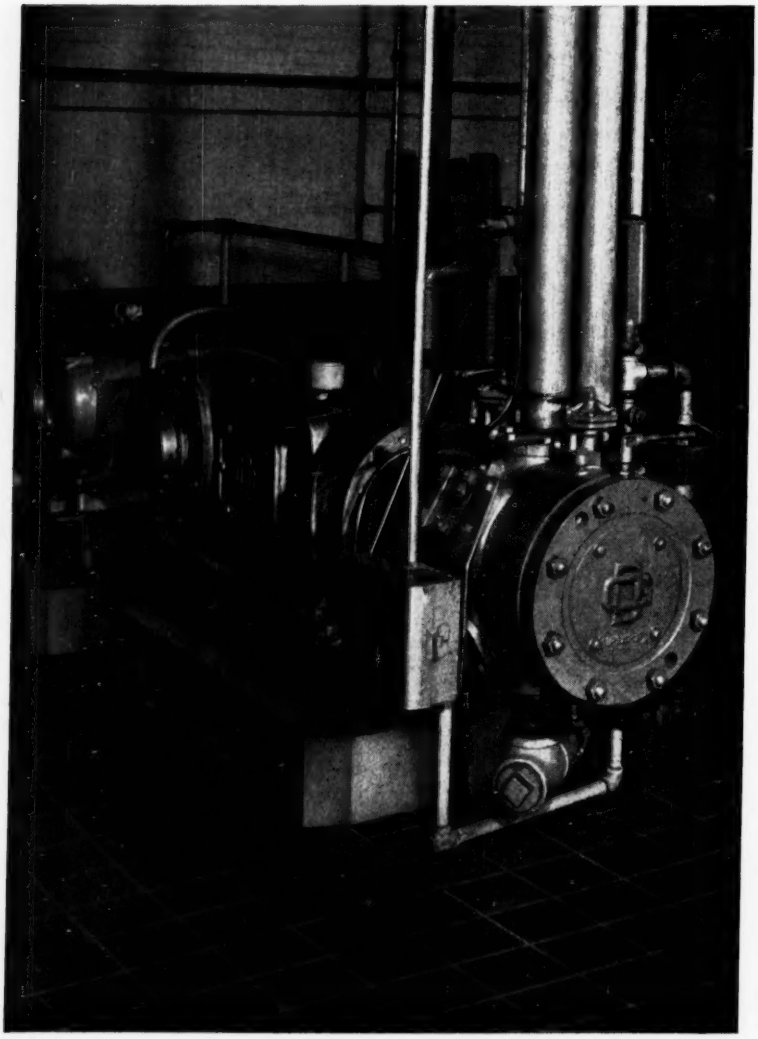
EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER DENVER

Pure, oil-free air that won't taint food, beverages or chemicals . . . won't clog sensitive control instruments . . . won't foul air-sprayed finishes. That's only one of the benefits when you install the CRX carbon piston air compressor. Carbon parts need no oil or water lubrication in the honed cylinder. Discharged air is pure and clean. Sizes from 100 to 1410 c.f.m. displacement. Write for Bulletin CRC-10. Ask about the smaller CACB oil-free compressor. Gardner-Denver Company, Quincy, Illinois.

No oil taint

...CRX carbon piston compressor



(*Continued from p.* 52)

samples. Known as the Sens-OAR-chrome, the device also provides control outputs of 0.25 w. or greater for control of processes with respect to color standards.

Principle of operation is based on a system known as Optical Automatic Ranging (see *Chem. Eng.* Dec. 15, 1958, p. 208).

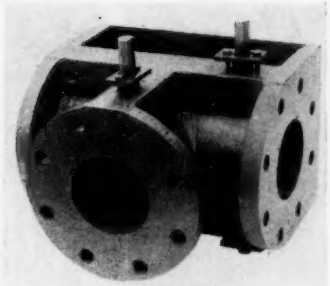
Enclosed in a metal case with carrying handle, the entire instrument weighs about 40 lb. Normal response speed is 2 sec. When very speedy response is necessary, variations may be perceived visually within about 1/120th sec. on an oscilloscope connected to the hue output circuit.—**Comapco, Inc., Encino, Calif.** **52G**

Disposable Boots

Low-cost product is worn once, then discarded.

Made of lightweight polyethylene film, new Footgard disposable boots can be pulled over the wearer's regular shoes and worn open at the top or closed with a rubber band. The boots are watertight, and will last for several hours before wearing through. The manufacturer expects that prime applications will fall in biological and atomic laboratories where control of contaminating elements is vital.

Packaged in rolls of 50 and 100, Footgard boots average less than 14¢ per pair. Initially, they are available in Large size only, but will be manufactured in other sizes as required.—**Plasticsmith, Inc., Pittsburg, Calif.** **130A**

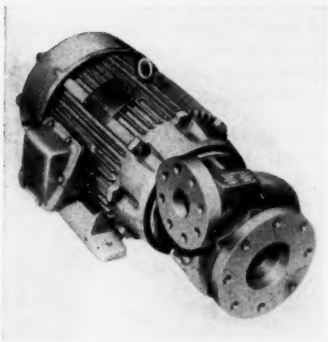


Flanged Valve

Designed to control flow of two process streams.

A two-in-one valve known as the Triangle Valve can do the work of two conventional butterfly valves and a flanged tee connection. The new unit gives perfect flow control in cooling systems and other applications where two streams flow to or from a single pipe.

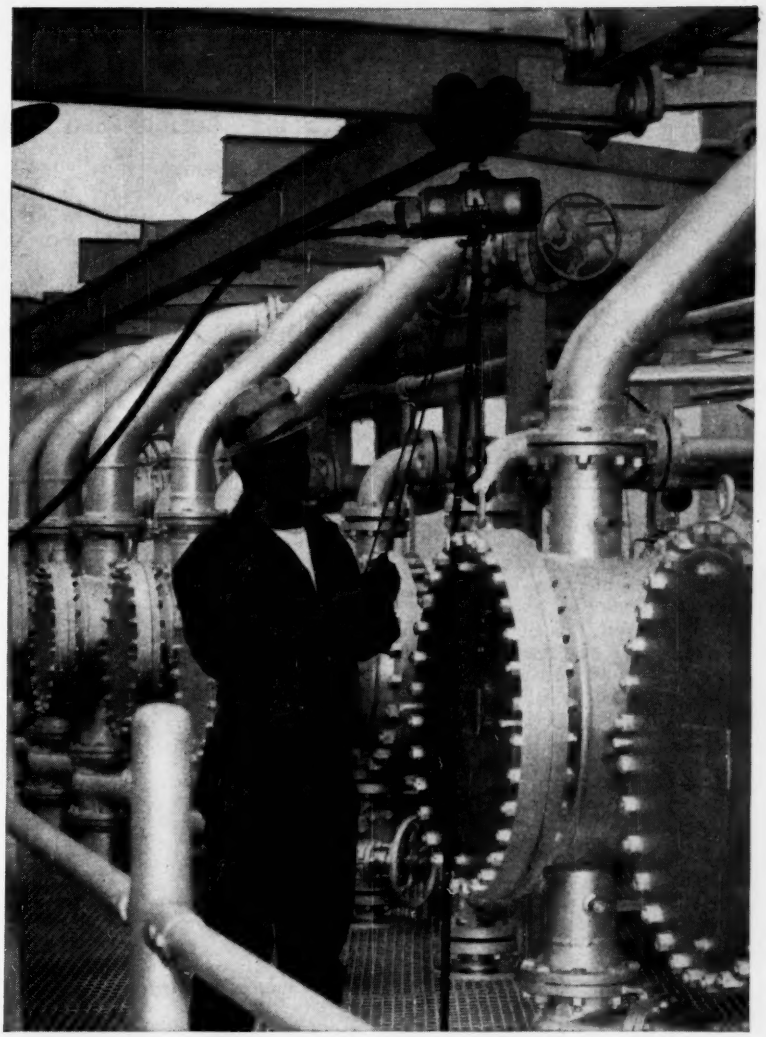
Shaft packing may be removed from either end of the shaft, inspected, replaced or adjusted without removing the valve. Constructed of corrosion-resistant materials, the valve comes in sizes 1 through 12 in.—**U. S. Valve & Engineering Co., Houston, Tex.** 131A



Transfer Pumps

For high-flow or intermittent duty.

Advantages claimed for a new family of close-coupled petrochemical and cryogenic transfer pumps include minimum maintenance, optional mounting and easy removal from piping systems. Capacities range from 10 to 8,000 gpm.



Fire-safe lift

with nonsparking air hoist

For the swift, safe lift that's free from fire and explosion hazards, use Gardner-Denver air hoists. Nonsparking axial-piston air motor makes these handy hoists ideal for jobs in chemical, gaseous or dusty atmospheres. In addition to their vital safety features, Gardner-Denver air hoists provide easily controlled speed for the quick, steady lift you need—with gentle starts and accurate stops. Capacities from 150 lb. to two tons. Write for Bulletin 80.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

We at KENNEDY VAN SAUN are looking forward to the Chem Show with keen anticipation, for it is always pleasant to talk to our old friends again, and to have the opportunity to meet new ones in the Chemical Industry.

This, then, is an invitation on behalf of our company and its management to stop at our booth, No. 1036, at the New York Coliseum during the week of November 30th.

We believe your visit with KENNEDY will be one of your most rewarding experiences of the entire Exposition. At our booth you will see complete KENNEDY plants pictured and described; you will find interesting information about all the process equipment made by KENNEDY; you will learn about the facilities, experience and achievements of KENNEDY'S Engineering and Research Departments. And, our New York Offices are but minutes away from the Coliseum. Our executives and our Engineering Staff are ready to help you with any extra service or information you need in solving your process problems. Please feel free to make arrangements at our booth.

We look forward to your visit.

President

See our products on pages 407-411 in your 1960 Chemical Engineering Catalog.

KENNEDY VAN SAUN

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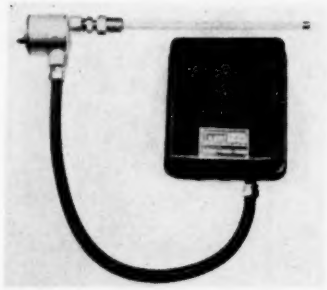
at differential pressures to 300 psi.

Of particular interest in cryogenic applications is the minimum "wet-end" weight that reduces "cool-down" time and minimizes liquid loss. Also, open construction between pump and drive reduces hazardous collections of gas in the pump area. Thermal barriers between pumps and motors minimize heat transfer.

Normally, the pumps come supplied with an electric motor drive. However, a complete range of separate bearing housings is available to permit direct coupling to steam or gas turbines. — **Turbocraft, Inc., Pasadena, Calif. 131B**

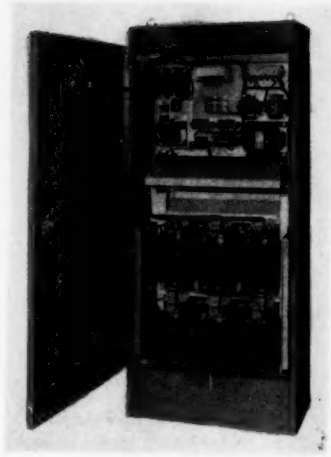


Level Indicator

Rugged instrument has no moving components.

Model 154 Level-Tel, a continuous, indicating level-measurement system, will function satisfactorily with most liquids, slurries, powders and granular solids. Features include simple calibration, unrestricted cable length between detector and transmitter, and high-order linearity.

Consisting of a probe, detector, transmitter and indicator, Level-Tel detects level change as a function of capacitance at the probe. Unbalance of capacitance circuitry feeds to the indicator via the transmitter as a d.c. signal proportional to level change. Detector circuitry is operable at temperatures ranging from —30 to 212 F. Probes can withstand —325 to 850 F., depending on type of insulation.—**Robertshaw-Fulton Controls Co., Anaheim, Calif. 132A**

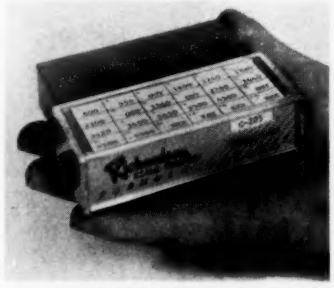


Electrical Drive

Compact, lightweight unit gives reliable service.

Using static power magnetic amplifiers, a new adjustable-voltage drive provides extremely high reliability coupled with quiet operation. Magnetic amplifiers and semiconductors control and rectify input power. Fail-safe circuits assure maximum protection of personnel and machinery.

Design eliminates warmup time and vibration. Models range from ½ to 200 hp., and feature an 8/1 speed range with 5% regulation. Standard modifications include dynamic braking, reversing, jogging and dynamic slowdown. — **Square D Co., Milwaukee, Wis. 132B**



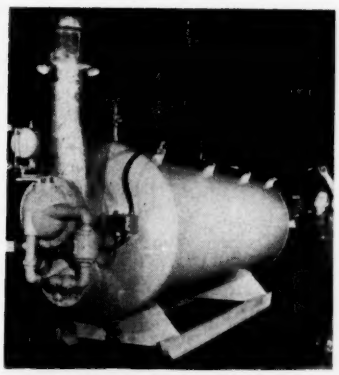
Batch Programmer

Rugged, compact capsule controls blending.

Integrated with the Select-O-Weigh automatic proportioning panel, a new pocket-size control

consisting of a network of miniature electronic components eliminates manual errors in blending, proportioning and batching operations. Each formula capsule is capable of programming the sequence and weighing of up to 24 solid and/or liquid ingredients in a single formula.

After the control capsule is inserted into the receiving slot of the panel, a touch of a button sets a fully automatic system into action. Visible figures on the capsule allow the operator to check scale operations as the cycle progresses.—**The Richardson Scale Co., Clifton, N. J.** 132C



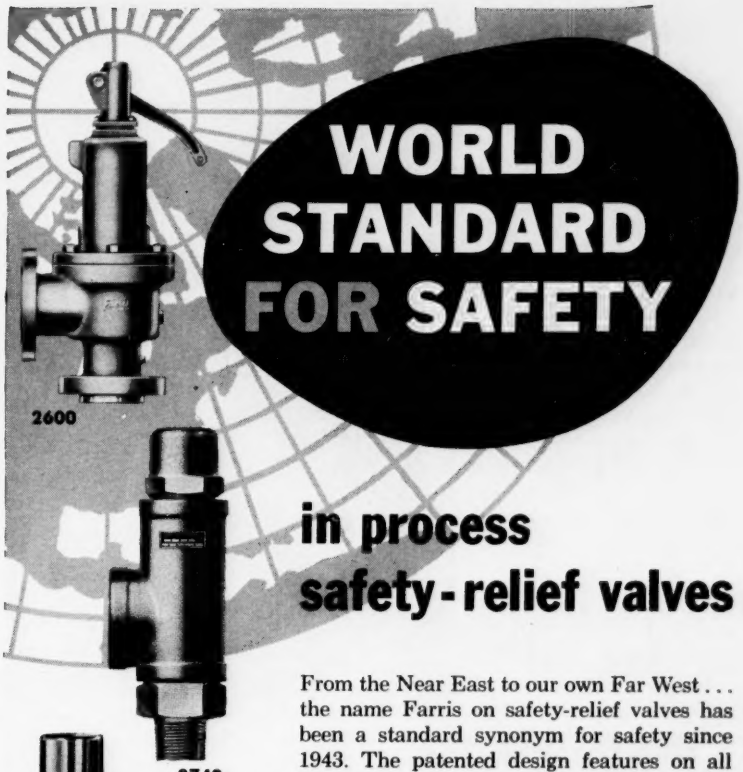
Water Heater

Assures scale-free heating at top efficiency.

Newest addition to Patterson-Kelley's equipment line is an indirect gas-fired water heater featuring a heat-transfer system that assures scale-free heating at efficiencies nearing theoretical maximum.

Scale-free unit storage heaters combine indirect firing and large-volume heating of service water. Each heater comes as a complete, self-contained package including controls.

In operation, burning gases pass through a cylindrical firetube, exchanging heat via a fin-tube exchanger to a heating medium, usually water. This heating medium then circulates through a tube bundle immersed in the storage water. Storage tanks are offered in 29 different sizes. Recoveries



WORLD STANDARD FOR SAFETY

in process safety-relief valves

From the Near East to our own Far West . . . the name Farris on safety-relief valves has been a standard synonym for safety since 1943. The patented design features on all Farris full-nozzle valves combine to offer the ideal concept of a trouble-free, 100% safe safety-relief valve for every application.

SERIES 2600

The most popular top-guided, self-aligning, safety-relief valve for process piping service. Maximum pressure, 150 to 2500 psig, RF/RJ. Plain or Lever types. Standard or BalanSeal bellows construction.

SERIES 2740

A cast-steel relief valve of simplified design for use where extreme blow down accuracy is not essential, but where durability, compactness are. Pressures to 3500 psig at 450°F; 2000 psig at 800°F. Sizes ½" to 2".

SERIES 2745

An extremely rugged, compact, high pressure bar stock nozzle valve. Internal parts stainless steel. Adjustable blow down; flat seat; self-aligning stem and disc. Pressure to 10,000 psig. Sizes ½", ¾", 1".

SERIES 2950

A cast iron safety-relief valve including most of the exclusive Farris features found in the Series 2600. Max. pressure, 250 psig at 450°F, 400 psig at 150°F. Plain cap, open lever or packed lever types.

Complete information is provided in Catalog FE-118, covering both selection and sizing of Farris process Safety-Relief Valves. Send for your copy today.

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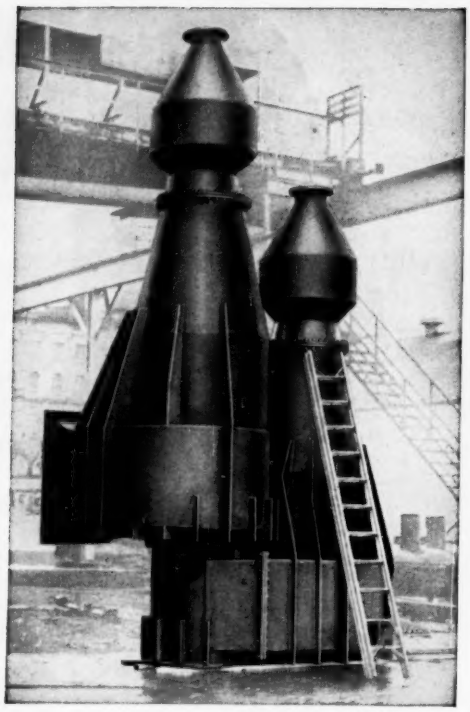
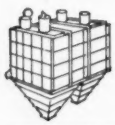


Exploring new frontiers!

But these aren't satellite launchers, though they're specially designed for high temperature operation: they're Buell extra-efficient cyclone dust collectors . . . and the new frontiers they're exploring are in industry. Everywhere in American industry, from cement mills to refineries, from chemical plants to power generating stations, Buell collectors set new records in percentage of dust removed, low maintenance, and improved plant operation. Even in the age-old field of fly ash collection, Buell extra efficiency pays off. Only *Buell* cyclones have the unique Shave-off port that traps small fines in the double eddy currents. And Buell large-diameter design eliminates bridging, clogging, or plugging. *All three* Buell Systems are illustrated and described in "The Collection and Recovery of Industrial Dusts". Write for a copy to Dept. 12-K, Buell Engineering Company, Inc., 123 William St., New York 38, N. Y.

BUELL CYCLONES



"SF" ELECTRIC PRECIPITATORS

PRECIPITATOR-CYCLONE COMBINATIONS

buell®

Experts at delivering Extra Efficiency in

DUST COLLECTION SYSTEMS

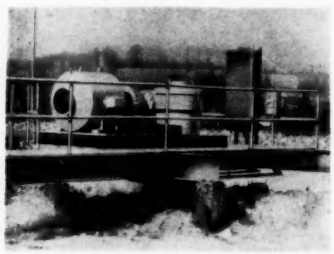
range from 375 to 2,125 gph.— **The Patterson-Kelley Co. Inc., East Stroudsburg, Pa.** **133A**

Face Shield

Safety unit combines vision with ventilation.

Kool-Vent face shield incorporates an optically correct acetate window within a fine-metal, 24-mesh screen. The unit is designed for use by industrial workers who require both visibility and face protection while working in heated areas.

An adjustable fiber headband holds the shield securely before the face. It can be worn with or without prescription eye glasses. Windows come in clear, green or aluminized designs.— **American Optical Co., Southbridge, Mass.** **134A**



Aerator

Turbine-type rotor has a lower power consumption.

Providing a new, low-cost means for introducing atmospheric oxygen into an aeration basin or lagoon at any desired

rate, the Vortair aerator claims highly conservative power consumption—it will dissolve 2.5 to 3 lb. oxygen/hr. per horsepower.

Simple in construction, the device is essentially a turbine-type mechanical aerator. In operation, it draws large quantities of atmospheric air into the liquid, keeps the liquid mixed and distributes oxygen uniformly.—**Infilco Inc., Tucson, Ariz.** 134B

BRIEFS

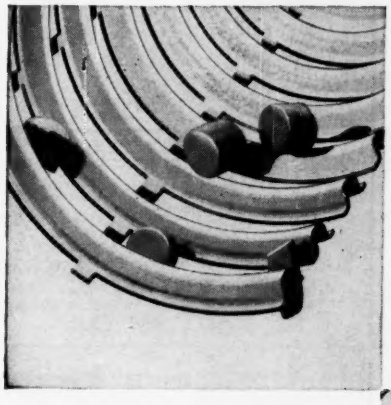
Temperature regulating system provides extremely accurate control for systems subjected to wide and sudden load swings. By cascading air signals to a pressure regulator, the instrument assures control accuracy of 6 to 8 deg. F. over a 24-hr. period. Valves are available for the new system in sizes ranging from ¼ to 12 in.—**Spence Engineering Co., Walden, N. Y.** 135A

Redesigned recorder features a modernized exterior. Up to 4 recording pens, for temperature, pressure, or a combination of the two variables are available. Recording range for temperature is −300 to 1,200 F.; pressures to 25,000 psi.—**U. S. Gauge, Sellersville, Pa.** 135B

Inverted bucket traps of new line come in sizes from ½ to 1¼-in. Construction is cast iron. Pressures range to 250 psi., and temperatures to 450 F. Design provides extra-large drainage capacities while holding physical size to a minimum.—**Clark Mfg. Co., Cleveland, Ohio.** 135C

Arc imaging furnace provides a completely integrated, non-contaminating heat source for temperatures to 2,000-4,000 K. Maximum attainable heat flux in the sample zone is 4.5 million Btu./(sq. ft.) (hr.). In principle, the tail-flame plasma from an arc struck between two carbons is concentrated by a ring of impinging air jets and stirred

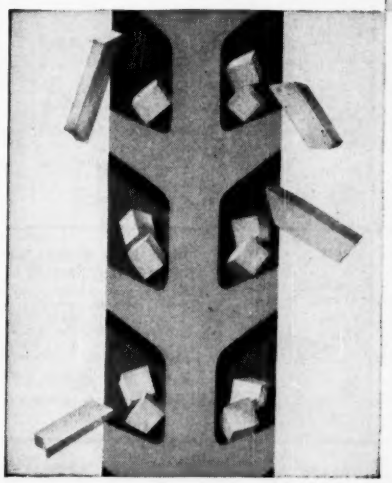
Lately more plastics materials are being sized and separated by Simon-Carter machines



CARTER GRADERS PERFORM THICKNESS, WIDTH SEPARATIONS

For sizing or separating free-flowing granular materials by *thickness*, Carter Precision Graders use revolving cylinders with *slotted perforations at the bottom of grooves*. Saddles between these grooves upedge the materials presenting them to the slots in an edgewise position. The thinner pieces pass through and the thicker pieces pass over and are conveyed to the end of the machine.

For *width* sizing or separating the Precision Graders use revolving cylinders with *round recessed perforations*. The recess causes the materials to be presented to the round perforations in an upended position. Narrow pieces pass through and wider pieces pass over for discharge at the end of the cylinder.



CARTER SEPARATORS ASSURE POSITIVE LENGTH SEPARATION

Carter Disc Separators contain a series of discs mounted on a revolving horizontal shaft. Each disc has hundreds of undercut pockets which select or reject plastics or similar materials according to *length*. As the discs revolve through a mixture of materials, the pockets lift out the shorter pieces. The longer pieces, too long to be held in the pockets as they rise, drop away from the discs.

Write today for complete information and descriptive folders on Simon-Carter machines.

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661 Nineteenth Ave. N. E. • Minneapolis 18, Minn.

DENVER Equipment

FOR THE CHEMICAL PROCESS INDUSTRY

DENVER AGITATORS AND MIXERS

Agitator types available: Turbine-type propeller (to 120" in tanks to 50' dia.), slow speed, high speed, air lift, vertical turbine mixers, mixer-settler units.

Write for Bulletin No. A2-B2

Lab and pilot scale agitators in **LG3-B10**

DENVER DIAPHRAGM PUMPS

Stroke can be adjusted while pump is operating. Long wearing nylon-reinforced rubber diaphragm. Sizes 1" to 10" simplex and duplex, capacity to 1000 g.p.m.

Write for Bulletin No. P8-B12

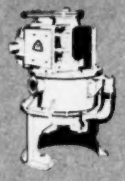
Lab and pilot scale diaphragm pumps in **LG3-B10**

DENVER ATTRITION SCRUBBERS

High power input to efficiently remove sand coatings, mix dense slurries. Rubber lined or acid-proof tanks. Sizes to 56"x 56".

Write for Bulletin No. A-8505

Lab and pilot scale scrubbers in **LG3-B10**

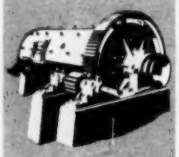


DENVER VERTICAL CENTRIFUGAL PUMPS

For handling frothy liquids or coarse, sandy slurries, constant or intermittent flow. No packing gland or sealing water. Standard or stainless steel construction. Capacity to 450 g.p.m.

Write for Bulletin No. P10-B5

Lab and pilot scale vertical centrifugal pumps in **LG3-B10**



DENVER BALL AND ROD MILLS

Offer operation and convertibility. Wet or dry grinding systems. All steel construction. Ceramic or rubber linings available. Sizes to 10'x 20'.

Write for Bulletin No. B2-B20

Lab and pilot scale mills in **LG3-B10**

DENVER SRL (RUBBER LINED) PUMPS

High efficiency, low horsepower. Parts last longer, cost less. Rubber lined. PUMPS AND PARTS IN STOCK. Sizes to 5000 g.p.m.

Write for Bulletin No. P9-B10

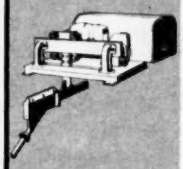
Lab & pilot scale SRL pumps in **LG3-B10**

DENVER JAW CRUSHERS

Cast steel frame, anti-friction side bearings and bumper bearings. Manganese steel jaw and cheek plates. Sizes from 2¼"x 3½" to 36"x 48".

Write for Bulletin No. C12-B12

Lab and pilot scale crushers in **LG3-B10**



DENVER SAMPLERS

Continuous mechanical and automatic types for dry, solution or slurry sampling. Complete sampling plants and sample processing equipment. SAMPLERS IN STOCK.

Write for Bulletin No. S1-B4

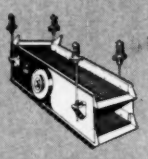
Lab and pilot scale samplers in **LG3-B10**

DENVER REAGENT FEEDERS

Both wet and dry feeders available. Let us know your requirements. Many standard units in stock.

Write for Bulletin No. F6-B8

Lab and pilot scale feeders in **LG3-B10**



DENVER-DILLON SCREENS

For efficient wet or dry screening. "True-Circle" eccentric action. Sizes to 6'x 14' in stock. Also Trommel Screens in sizes from 30"x 60"x 120".

Write for Bulletin No. S3-B15

Lab and pilot scale screens in **LG3-B10**

DENVER "SUB-A" FLOTATION

Universal tank with three types of mechanisms: (a) "Cell-to-Cell"; (b) "Free-Flow"; (c) Type "M". Sizes from 16"x 16" to 72"x 72".

Write for Bulletin No. F10-B86

Lab and pilot scale flotation in **LG3-B10**

DENVER SPIRAL RAKE THICKENERS

Move settled materials to center in one revolution. Simple, efficient, heavy-duty gear mechanism for thickeners to 150' dia. Acid proof construction available.

Write for Bulletin No. T5-B6

Lab & pilot scale thickeners in **LG3-B10**

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SEE OUR CATALOG ON PAGES 997-1004 IN CEC.

DENVER TESTING FACILITIES

You will have problems in crushing, grinding, settling and possibly concentration and filtering. These are our specialties so please let us help you in our Test Department. Deco flowsheets are reliable and proven.

by a magnetic field.—**Arthur D. Little, Inc., Cambridge, Mass.** 135D

Utility blowers developed for use with corrosive fumes come in three models with capacities ranging from 399 to 2,000 cfm. Housing and multiblade wheel are constructed of rigid polyvinyl chloride. Maximum permissible inlet temperature is 140 F.—**Industrial Plastic Fabricators, Norwood, Mass.** 136A

Gravity filler for cans, bottles and other containers features drip-proof spout. Capable of handling containers up to 1-gal. capacity, the filler is claimed to be superior for foaming liquids. Liquid-contact parts are stainless steel. —**Ertel Engineering, Kingston, N. Y.** 136B

Bimetal tubes for condensers or heat exchangers are available for applications involving different internal and external corrosive operating conditions. Sizes from ⅜ to 6 in. Choice of ferrous and nonferrous metals.—**Chase Brass & Copper Co., Waterbury, Conn.** 136C

Equipment Cost Indexes . . .

	March 1959	June 1959
Industry		
Avg. of all.....	232.6	234.3
Process Industries		
Cement mfg.	225.8	227.9
Chemical	233.7	235.7
Clay products	219.4	221.5
Glass mfg.	220.7	222.5
Paint mfg.	224.4	226.6
Paper mfg.	225.2	227.1
Petroleum ind.	229.2	231.4
Rubber ind.	232.0	234.0
Process ind. avg...	230.1	232.8
Related Industries		
Elec.power equip...	236.5	246.7
Mining, milling	235.2	237.1
Refrigeration	262.2	264.7
Steam power	219.7	221.8

Compiled quarterly by Marshall and Stevens, Inc., of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124—6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.

PEOPLE . . .

TECHNICAL BOOKSHELF

J. B. BACON

Not Deep, But Handy

THE CHEMISTRY OF INDUSTRIAL TOXICOLOGY, 2nd ed. By Hervey B. Elkins. John Wiley & Sons, Inc., New York. 452 pages. $11.50.

Reviewed by Alvin Davis, Department of Preventive Medicine and Industrial Health, University of Cincinnati, Cincinnati, Ohio.

Revision of Elkins' original book consists of 17 chapters and an extensive bibliography. As in the earlier edition, it may be considered as divided into two general sections.

The first section is concerned with the hazardous nature of industrial materials and contains a great deal of general and specific information regarding the toxicity of many substances of economic importance. There is a short chapter on preventive measures as well. The second section is devoted to the quantitative assessment of hazards and includes chapters on air sampling devices and on analytical methods and procedures for atmosphere appraisal.

By the author's own description, this book attempts to treat industrial poisons from the point of view of the chemist and the engineer. The data describing the toxicity of substances should be of value to those persons concerned with process design and production. Unfortunately, a large number of substances are covered in a relatively small amount of space and, with but few exceptions, the treatment accorded them is brief.

The chapters on air sampling and analytical methods should be of interest to those concerned with the control of hazards in existing operations. Here again, there is an attempt to cover a large number of methods in a limited amount of space and the treatment of many of these areas is limited. There is no mention of the physical analytical methods such as gas chromatography and x-ray diffraction analysis which have assumed increasing importance in recent years.

The chapter on preventive measures is for the most part a good outline of general preventive techniques. Some of the medical measures cited, however, do not represent current thinking in the field.

Despite the lack of depth, this book provides a handy reference to the chemical hazards of industry and should be useful to those persons engaged in process design and production.

BRIEFLY NOTED

OCEANOGRAPHIC SURVEY OF THE CONTINENTAL SHELF AREA OF SOUTHERN CALIFORNIA, 560 *pp. State Water Pollution Control Board, Room* 316, 1227 *O Street, Sacramento* 14, *Calif.* $4 *plus* 16¢ *sales tax in state of California.* Report designed to fill need for studies relating to biological evaluation of waste-receiving waters.

PROCEEDINGS OF MIDWESTERN CONFERENCE ON FLUID MECHANICS AND SOLID MECHANICS (2 vols.) *Engineering Institutes, Div. of Extension, University of Texas,* 18*th and Red River Streets, Austin, Tex.* $12.50 *per volume.* Two volumes, one on fluid mechanics, one on solid mechanics, give proceedings of conference held Sept. 9-11 at Austin, Tex.

MORE NEW BOOKS

KINETICS OF HIGH-TEMPERATURE PROCESSES. Edited by W. D. Kingery. Wiley. $13.50.

CHEMICAL PROCESS PRINCIPLES, Part II: Thermodynamics, 2nd ed. By O. A. Hougen, K. M. Watson and R. A. Ragatz. Wiley. $9.75.

STANDARD PLANT OPERATOR'S QUESTIONS AND ANSWERS. By Steve Elonka and Joseph F. Robinson. McGraw-Hill. Vol. I, $8; vol. II, $8; 2-vol. set, $14.95.

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Delhi nitration grade Benzene and Toluene and Delhi Xylenes have set a new standard in purity and uniformity. They are sulfur and thiophene-free with remarkably low paraffin content.

Delhi-Taylor keeps a careful watch over product purity through its unique "Triple-Testing" procedure.

The first test is made on-stream where rigid process control standards are maintained; the second test is made in storage to make certain that the product maintains its high quality during storage; the final test sample is taken from the barge or tank car before it is released to the customer.

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Something much finer in a dial thermometer: finer because it is the bourdon tube type of thermometer at its best...embodies the greater precision and lasting accuracy of the Marsh Pressure Gauge.
Both vapor tension and gas-filled types are available in either distant reading or rigid stem types. In the broad Marsh line you have a complete selection of temperature ranges, case sizes, styles, and finishes.
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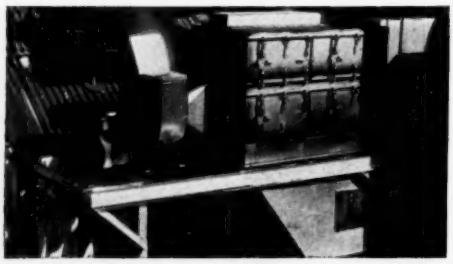
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd.
8307 103rd St., Edmonton, Alberta, Canada
Houston Branch Plant, 1121 Rothwell St.
Sect. 15, Houston, Texas



Barely visible discharge from exhauster in this unretouched photo shows how Dustex Miniature Cyclone Collector ended a problem for Perlite Products Co.—while recovering 70 lbs./hr. with no maintenance.

"95% PREDICTED EFFICIENCY PROVED... and Collector is maintenance-free!"

Frank W. Schaffer, President of Perlite* Products Co., Primos, Pa., writes this about his Dustex Miniature Cyclone Collector purchased on a basis of the Dustex Single Tube Determination test:

"Your predicted efficiencies of 95% are proven ...collecting 70 lbs./hr. of 85% below-325-mesh material at 450°F...complaints on discharge are ended, and the collector is maintenance-free."

*Perlite ... extremely lightweight material for insulation and filtration, with a bulk density as low at 3.5 lbs./cu. ft.

Write Today for Dustex Bulletin "A Simplified Test Method" describing actual collection test at your plant at no obligation.

25 ANDERSON ROAD • BUFFALO 25, N.Y.

dustex CORP.

LETTERS:

Con: Formula-Pluggers

Sir:

I read with interest the article "Say *Engineer* When You Mean Engineer" in your Aug. 24 issue (pp. 148-152).

In many respects a campaign to impress upon the public the distinction between scientists and engineers is rather silly. To promote better public understanding of the engineering profession, to further registration of engineers, to provide proper representation for engineers—these are worthwhile objectives. To impress on John Q. Public the fact that engineers and scientists perform different functions is worthless.

How many of your readers in the chemical field can define where chemistry stops and chemical engineering starts? Let's not publicly emphasize the fact that many "engineers" are nothing but formula-pluggers.

In crediting those responsible for his material benefits, John Q. Public, perhaps unconsciously, includes engineers and scientists under one term (as the U. S. Army does). I am proud to be included in the same generic term with those men "who make it known."

PETER C. WILLIAMS
Chemical Warfare Laboratories
Army Chemical Center, Md.

Ch. E.: Science or Art?

Sir:

Is chemical engineering a science or an art?

I think the vast majority of chemical engineers would answer that it is a science. Your magazine seems to adopt the attitude that chemical engineering is an art.

You present equations without derivations, data without experimental methods and charts without supporting data. An outstanding example of these practices is Aaron Feder's article in the Sept. 21 issue ("Chart Pre-

PRO & CON

C. H. CHILTON

dicts Evaporation Rates," pp. 159-162). You add insult to injury by saying that theory and assumptions are available on request. If the charts are a worthy contribution to the field, they should be accompanied by the derivation.

It seems to me that presentation of material in this way can be likened to giving a loaded pistol to a two-year-old child.

HENRY H. GEORGE

Troy, N. Y.

► *Maybe we're just old fogies, but in our opinion chemical engineering is both a science and an art. AIChE seems to agree with us in its official definition of chemical engineering as "the application of the principles of the physical sciences, together with the principles of economics and human relations."*—ED.

Pro: Stock Options

Sir:

The article on p. 142 of your Aug. 10 issue, dealing with compensation of top executives, is completely misleading. It neglects the value of stock options.

For example, Du Pont President Crawford Greenewalt received a total of $314,489 for 1958, counting salary, bonus and dividend units. His main compensation, however, was in the options he received for 2,092 shares of stock at $213.75 per share.

Du Pont stock has increased in value at least $20/yr. over the last eight years. Assuming it continues to increase in value at the modest rate of $20/yr., each option is worth a minimum of $35, since 50% may be exercised after one year, 25% in two years and 25% in three years. (Actually, the value of these options is already in excess of $50 per share.)

Mr. Greenewalt's profit on these options will be treated as capital gains, taxed at 25%, rather than as salary, taxed at 91%. Thus these stock options are worth the equivalent in addi-

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The name you can depend on when you see it on any viscosity measurement or control instrument.

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You are a scientist, the coming Chem Show will be our meeting ground. Booth #855-57 will conveniently show in live operation the Brookfield Viscometran now in use successfully for polymerization end point determination and continuous "in process" viscosity recording. See and try, the famous Brookfield viscometers in a broad range of models, look over the many Brookfield accessories which give the Brookfield viscometer its famous flexibility. At the Chem show, anytime, make Brookfield your first source for viscosity information.

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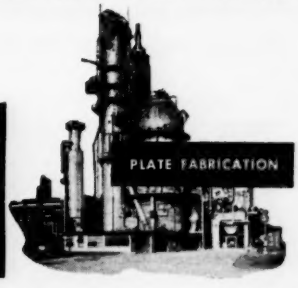

PLATE FABRICATION

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Plants at

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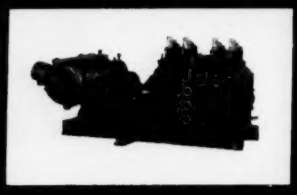
The accepted source for lubricator requirements up to 30,000 psi will also solve your other lubrication problems. Manzel's outstanding dependability is built into every model. Experienced field engineers at your service.



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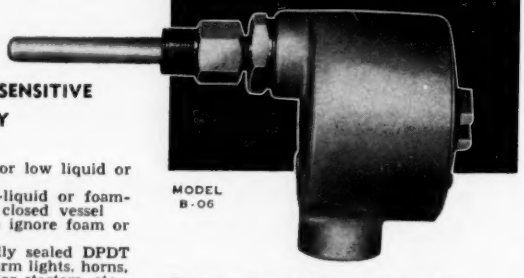

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1. Will indicate high or low liquid or solid level
2. Will control liquid-liquid or foam-liquid interface in closed vessel
3. May be adjusted to ignore foam or detect foam
4. Contains hermetically sealed DPDT relay to energize alarm lights, horns, solenoid valves, motor starters, etc.
5. Teflon covered probe

ELECTR-O-PROBES are available in three models —

B-04 — super-sensitive relay for foam, interface, etc.
B-05 — general purpose relay for liquid or solid level detection
B-06 — self-contained, general purpose, tank-side mounting

ELECTR-O-PROBES are used NOW for detection of heavy fluids, acids and fluid interface in chemical plants; alarm for refrigerant control in freezing plants; mixed feed control; water-oil interface in refineries; detection of liquors and foam in pulp and paper mills.

WRITE FOR BULLETINS

INSTRUMENTS INCORPORATED
TULSA
INSTRUMENTS, INC.
BOX 556 TULSA, OKLA.
PIONEERS IN LEVEL MEASUREMENT AND CONTROL INSTRUMENTATION

tional salary of $605,000. This brings his grand total for 1958 to an equivalent salary of $915,000.

CHESTER E. ROSE
Montrose, Pa.

▶ *Whether or not an estimated or assumed value of stock options should be counted as equivalent salary is a debatable point.*

Several years ago we ran an article on executive compensation titled "Why Are They Worth So Much?" (Nov. 1956, *pp.* 238-244). *In a letter commenting on this article* (*Jan.* 1957, *p.* 302), *Neil McElroy brought up a similar point, dealing with our inclusion in his* 1955 *income of a profit-sharing-trust credit which was available only at the time of retirement.*

But regardless of how you figure it, Mr. Greenewalt's total is certainly "grand."—ED.

Pro: Writing Engineer

Sir:

Thank you for the reprints of my Oct. 5 article ("How We Encourage Engineers to Write," pp. 162-166).

I believe that our recruiting teams might be able to use the reprints in their efforts to encourage other engineers to join Convair. Perhaps news of our writing award program will sway the engineer who is wavering between joining Convair or some other company.

NELSON FULLER
Convair Div.
General Dynamics Corp.
San Diego, Calif.

Sir:

As a strong advocate of the "writing engineer" I was glad to read Mr. Fuller's interesting article. I have only one complaint.

The article proceeds logically from step to step, explaining the reasons for encouraging engineers to write, the methods for so doing and the results of a soundly thought-out program. But when the author compares the cost (to Convair) of placing 114 articles with the cost of the equivalent amount of advertising space, he throws reason and logic to the winds.

Publicity and advertising are two completely different tools. When either is used to do the

job of the other, the result is ineffectual and costly. I am reasonably certain that many of the magazines accepting Convair articles (with some resultant benefit to Convair) include a large number who would never be justified as media for carrying the company's advertising.

If you could validly equate publicity and advertising space, the purchase of space would become a necessary evil, to be employed only when a company's technical writers ran out of ideas and subjects. On the contrary, companies with the largest and best-administered technical writing and publicity programs are usually those who do the most consistent space advertising job.

GEORGE BLACK
Sprout, Waldron & Co.
Muncy, Pa.

Con: Crystallization Patent

Sir:

We have read the letter from Stamicarbon N. V. of the Netherlands in your Aug. 10 issue (p. 195) regarding patents on continuous crystallization of naphthalene and anthracene.

We should like to inform you and your readers that B. P. 811,559 is not yet in force and that an opposition has been entered thereto on the grounds of prior publication, prior user and obviousness.

We were the designers of the plant referred to in the article, "Crystal Fractionation Beats Distillation," published in your April 6 issue (pp. 80-82). At the time we designed this plant, and afterwards when we gave information to your reporter, we were unaware that application for B. P. 811,559 had been made. We do not believe that our plant, which is entirely of our own design, has either infringed or would infringe any valid patent rights.

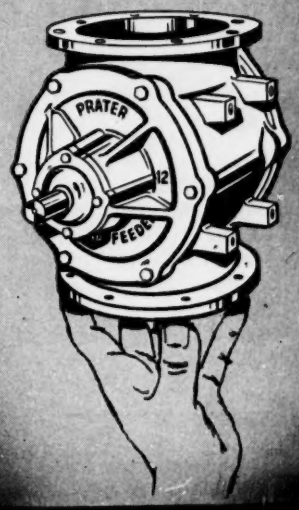
We do not claim to have made any invention. All that we claim is that we have found the best arrangement and type of equipment to deal with a particular problem.

J. MOLINARI
Proabd (England) Ltd.
London, England

PRATER — *the recognized leader*

ROTARY AIRLOCK FEEDERS

for DUST CONTROL and PNEUMATIC CONVEYING



WRITE FOR BULLETIN P58

PRATER PULVERIZER COMPANY
1517 South 55th Court • Chicago 50, Illinois

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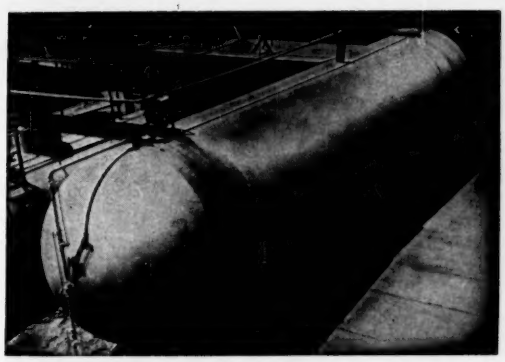

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Elevated Tanks, Pressure Vessels, Chemical and Processing Equipment from Aluminum, Stainless and Carbon Steel, Monel and Other Alloys.

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READER SERVICE . . .

TECHNICAL LITERATURE

E. M. FLYNN

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Chemicals

Caustic Potash.....New Technical Bulletin 15 is crammed with facts, tables, diagrams for applying caustic potash. Data on unloading, handling, etc.
43 *Allied Chem., Solvay Process Div.

Catalysts.....Facilities for producing carload quantities of performed catalysts to fit special process requirements. Booklet, "Harshaw Catalysts" is offered.
59 *The Harshaw Chemical Co.

Chemicals.....1959–1960 edition of general catalog, 44 p., lists properties & uses of 375 industrial, pharmaceutical, agricultural chemicals currently produced.
142A Dow Chemical Co.

Chemicals.....6 p. Bulletin P-102 contains a complete list of industrial and specialty chemicals offered by company. Physical properties, shipping information.
142B Eastman Chemical Products

Chemicals.....Samples & technical literature on allyl alcohol, allyl chloride, bisphenol A, dimethyl ketone, epichlorohydrin, ethyl amyl ketone, etc. available.
Cover *Shell Chemical Corp.

Chlorinating Agents.....21 p. illustrated technical bulletin 328-B summarizes methods and types of reactions in which company's agents are advantageously used.
142C Hooker Chemical Corp.

Coatings.....Formulations for cold applied solvent coatings which contain asphalt-asbestos are compiled in 12 p. booklet. Covers aluminum & plastic roof coatings.
142D American Smelting and Refining

Dicyclopentadiene.....possesses high purity & uniformity. Used as an extender for drying oils. Complete information in technical data sheets No. 1 & No. 2.
91 *Enjay Company, Inc.

* From advertisement, this issue

Dihydropyran.....13 p. bulletin 137 describes newly available 2,3-dihydro-4 H-pyran. Gives physical & chemical properties, details on various types of reactions.
142E Quaker Oats Co.

Elastomer.....Fluorel is a new high-temperature elastomer resistant to corrosive chemicals, fuels & solvents. Brochure covers properties, applications, etc.
142F Minnesota Mining & Mfg. Co.

Furfural and Furfaryl Alcohol.....as reactive solvents put abrasives in a "bind." Complete information contained in Bulletin 126. Available on request.
37 *The Quaker Oats Co.

Hexachloroacetone.....is a strongly ketonic, non-flammable chemical intermediate & solvent. Product Information Data Sheet is now available request.
23 *Allied Chem., General Chem. Div.

Inert Fluids.....Complete data on the remarkable properties of 3M Inert Fluids in terms of your product design, miniaturization or performance problems.
122 *Minnesota Mining & Mfg. Co.

Lithium.....8 p. bulletin 101 on lithium metal covers available forms, physical properties, chemical properties. Numerous phase diagrams on binary alloys.
142G Foote Mineral Co.

Lubricating Greases.....New booklet contains the complete story in pictures of the research & manufacturing facilities of the many types for lubricating purposes.
142H Standard Oil Co., Indiana

Pharmaceuticals.....11 p. report on a new drug, triparanol, suggested as an approach to controlling cholesterol bioproduction, contributing cause of heart disease.
142I Wm. S. Merrell Co.

Polyolefins.....16 p. booklet describes Montecatini's facilities for research, manufacture, product development and marketing in this new field. Send for your copy.
142J Chemore Corp.

Polyvinylpyrrolidone.....16 p. Bulletin, AP-89 Revised, describes recently published techniques for use of pharmaceutical grade PVP in tablet manufacture.
142K General Aniline & Film Corp.

Primer, Red Lead.....Summary test results and a formulation for a new red lead-coumarone primer for seawater immersion are covers in 4 p. Red Lead Technical Letter No. 14.
142L Lead Industries Assn.

Raw Materials.....Products for the rocket and missile industry such as; fluids, structural materials, elastomers, friction materials, etc. are covered in a new brochure.
142M Minnesota Mining & Mfg. Co.

Resins, Tooling.....2 p. checklist, "Maraset Tooling Resins," is intended for general reference to types of materials available. Resins listed numerically.
142N Marblette Corp.

* From advertisement, this issue

Rust Preventive.....Bulletin describes Petronate CR which can be used interchangeably with a variety of different carrier oils without affecting its rust preventive effectiveness.
142o L. Sonneborn Sons, Inc.

Silicone Fluids.....Engineering properties of silicone fluids have been assembled in a handy design file. Some graphs are on sheets permitting work to be done on them.
142P Union Carbide Corp.

Silicone Rubber.....12 p. bulletin, CDS-170A, contains product and application data on family of room temperature vulcanizing silicone rubber compounds.
142Q General Electric Co.

Specialties.....New bulletin describes Separaids, a family of products that aid in dewaxing and deoiling of lube oil solutions. Includes complete application and test data.
142R L. Sonneborn Sons, Inc.

Sulphur.....Manual covers all phases of the handling, storage & use of Sulphur, both solid & molten, plus useful information on sampling, analyzing, & broad properties.
113 *Texas Gulf Sulphur Co.

Surfactants.....24-p. bulletin describes various forms of liquid concentrates for wetting, emulsification, suspension, dispersion as well as solid surfactants.
142S Swift & Co.

Surfactants.....44 p. booklet describes properties and uses of eight nonionic and four anionic Tergitol surfactants including selection, solubilities, properties, testing.
142T Union Carbide Chemicals Co.

Urethane Foam.....4 p. bull., PAB No. 4-F3 by M. Glickman, Test Engr., American Bridge Div., U. S. Steel Corp. is titled "Urethane Foam in Curtain Wall Construction."
142U Mobay Chemical Co.

Vermiculite.....3 p. data sheet on bright gold flake derived from Vermiculite covers description, uses, typical screen analysis and properties, samples.
142V Engineered Materials

* From advertisement, this issue

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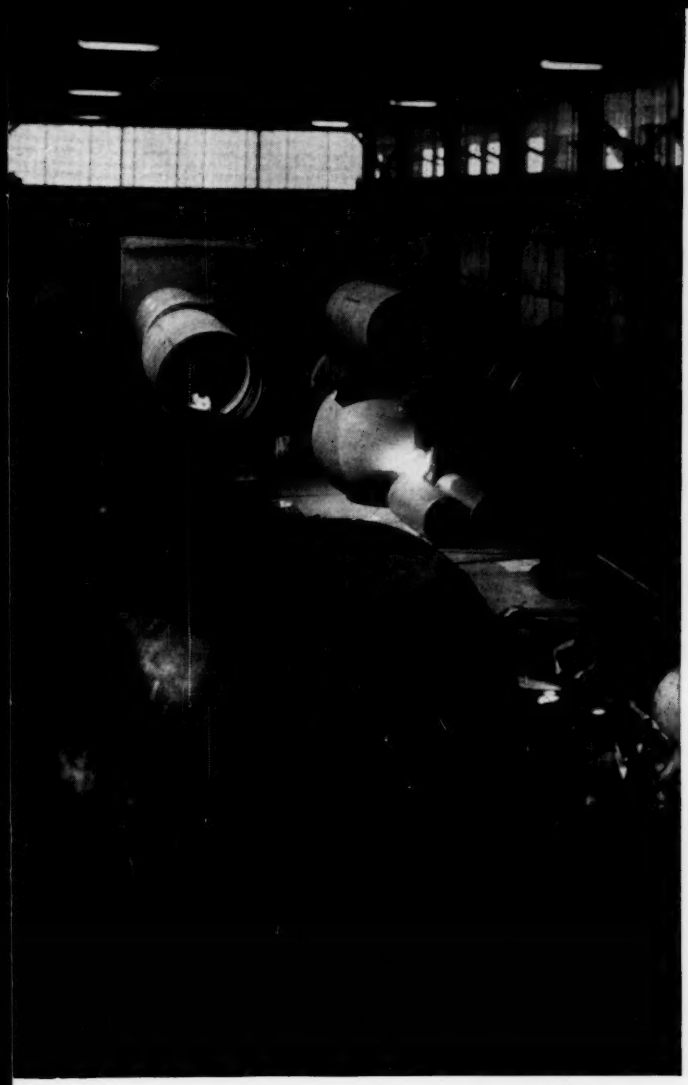

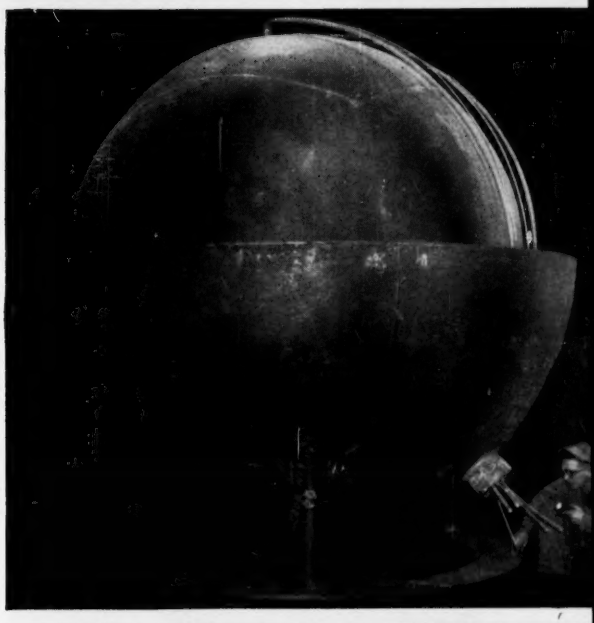

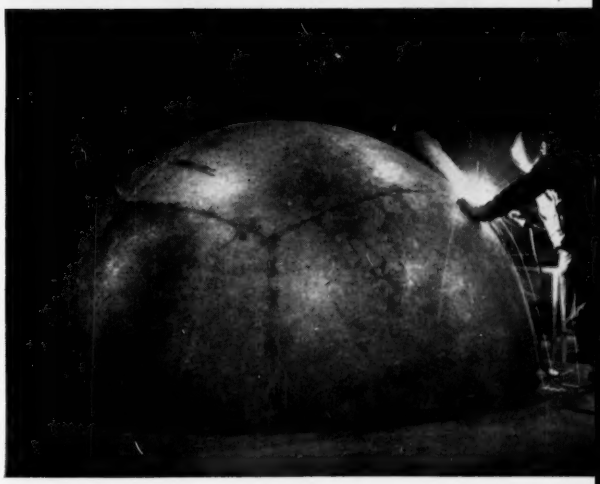

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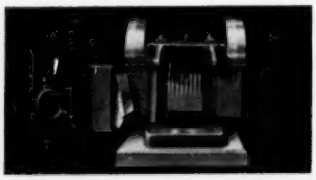
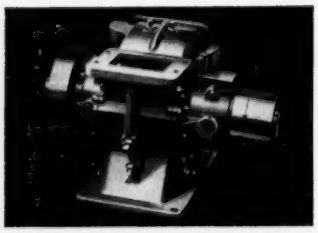
Lab Crushing Rolls: Special lab design. Two models: 8 x 5 in. and 12 x 12 in. rolls. Capacities to 10 tph. Both models adjust down to 20 mesh. Tires of high carbon forgings. Automatic feeder, adjustable controls.



Lab Jaw Crusher: Crushes hardest rocks at ½ to ⅛ in. settings. Roll jaw action — no clogging. Feed opening 2 x 6 in. Capacity to 1900 lbs. per hr. at ½ in. setting. Instant adjustment. Manganese jaws, reversible shield.



Lab Swing-Sledge Mill: 5 x 6 in. opening takes soft, medium, tough or fibrous feed. Capacity to 1 tph. Fines regulate from 1 in. to 20 mesh. Choice of gratings, hammers (or knives).

Sample Grinder: Disc type grinders for dry, friable soft or medium materials. Three sizes — 6 in., 10 in., and 14 in. take feed as coarse as ¼ in. Produces 100 mesh fines at capacities to 200 lbs. per hr. on largest model. Regulate 10 to 100 mesh. In-operation adjustment.

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Construction Material

Aluminum Fittings.....New catalog covers line of aluminum alloy welding fittings and flanges. Dimensional data and comprehensive technical section.
144A Flowline Corp.

Coating, Zinc.....is applied in one coat-completely self-curing. Completely nonflammable, nontoxic. Resists temperatures up to 600 F. Complete information on request.
115 *Amercoat Corp.

Construction & Maintenance.....Booklet contains engineering data and specifications to help solve problems of waterproofing, painting, roofing, flooring and caulking.
144B L. Sonneborn Sons, Inc.

Nuclear Tubing.....Nuclear quality fuel element tubing is described in Specification STC-102. Outline of quality and technical aspects of tubing. Stainless.
144C Superior Tube Co.

Plastics.....Boltaron 6200 protects against most corrosive fumes & liquids in any combination. Chemically inert. High dielectric strength.
144D General Tire & Rubber, Bolta Div.

Specialty Steels.....New guide for buyers of specialty steels contains detailed information on special alloys, tubing, pipe and fine wire specialties.
144E Carpenter Steel Co.

Wire Cloth.....Bulletin describes and illustrates a broad line of industrial wire cloth. Includes filter cloth, centrifugal cloth, etc. Selection, ordering data.
144F Newark Wire Cloth Co.

Electrical & Mechanical

Circuit Breakers.....Revised version of "Interrupting Capacity Chart" aids selection and ordering of the proper breaker for each application. Includes company's new products.
144G Westinghouse Electric

Conduit Fittings.....Solid Aluminum Electrolets has resistance to corrosion. Gives extra strength at points of stress. Catalog of electrical fittings & fixtures offered.
56 *Killark Electric Mfg. Co.

Condulets.....Descriptive literature and specifications on types DMC and WMC combination line starter condulets are offered for your information.
18 *Crouse-Hinds Co.

Electromagnetic Clutches.....Detailed information on a complete line of Electro Clutches with capacities to 13,000 lb.-ft. is furnished in new bulletin. Six series.
144H I-T-E Circuit Breaker Co.

Drives.....“Automator Variable Speed Drive” is the title of a new booklet describing features of the manufacture's individually engineered drive units. On request.
144I Marathon Electric Mfg. Corp.

Motors..... New data on the complete line of C-W Sealedpower motors is given in Bulletin PB 6000-2. Effective sealing gives motors better protection against dust, etc.
31 *Elliott Co.

Power Control Units.....New line of power control units utilizing magnetic gating amplifiers driving silicon-controlled rectifiers is topic of Bulletin S-1075.
144J Magnetic Amplifiers, Inc.

Speed Reducers.....Information on a complete line of helical gear speed reducers is contained in Book 2751. Tables of load classes, ratings, selection data.
144K Link-Belt Co.

Speed Reducers.....New 65-page catalog gives information on the manufacturer's line of Hi-Line speed reducers. Engineering data, dimensions and applications.
144L Ohio Gear Co.

System-Engineering Equipment..... Bulletin GEA-6684A, “Semiconductor Rectifier Power Conversion Systems” & other technical assistance is available.
94-95 *General Electric Co.

Turbine Pump Motors.....New brochure features cross-section of the Unibase motor, the first vertical pump motor designed for short-coupled industrial pumping service.
144m U. S. Electrical Motors, Inc.

Turbines.....Multi-stage, hi-speed turbines available in five frame sizes with wheel diameters ranging from 12 in. to 32 in. Details available.
67 *Westinghouse Electric Corp.

Variable-Speed Drives.....Catalog explains in copy and photos the wide range of styles, modifications and accessories for the Reeve line of variable-speed drives.
144N Reliance Electric

Handling & Packaging

Air Hoist.....is powered by a non-sparkling axial-piston air motor. Available from 150 lb. to 2 tons. Further information contained in Bulletin 80.
131 *Gardner-Denver Co.

Drums, Stainless Steel.....for safe, contamination-free handling of acids, essential oils, solvents, perfumes, viscous materials, etc. Full specifications available.
13 *Pressed Steel Tank Co.

Materials Handling.....Dinosaur picks up automatically. Containers available up to 40 cu. yds. & over . . . loads are limited only by the capacity of truck. Brochure.
151 *Dempster Brothers Inc.

Materials Handling Equipment..... The “FT” series fork truck designs are covered in detail in Bul. 489. Includes capacity charts & engine specifications of all models.
144B Allis-Chalmers

Tanks.....for chemical storage. Also pressure vessels and processing equipment of aluminum & special alloys. Copy of “Tank Talks” on request.
B141 *R. D. Cole Mfg. Co.

* From advertisement, this issue

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Magnesium Oxide MgO

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41-59

Heating & Cooling

Deaerating Heaters.....Bulletin on spray-type deaerating heaters discusses principles of operation, standard designs, features and accessory equipment.
146A Graver Water Conditioning

Drying Equipment.....Catalog describes the manufacturer's complete line of drying equipment. Photos and diagrams illustrate drying methods and their special features.
146B J. P. Devine Mfg. Co.

Finned-Tube Exchangers.....Bulletin 11R describes line of Radiafin heat exchangers for air and gases. Illustrates the continuous, spiral-wound fins. Many designs.
146C Schutte & Koerting Co.

Heat Transfer.....Multi-zone Plate-coil configuration with multiple headers produces a reserve capacity for faster start-up & better temperature maintenance. Bul. P61.
14 *Tranter Mfg. Inc.

Heating Systems.....Information booklet on Aroclor 1248 heating systems and guide to heater selection is available. Its compact design saves space.
127 *Monsanto Chemical Co.

Industrial Dryers.....Bulletin 59-L covers selection, construction and descriptions of the manufacturer's line of dryers and calciners.
146D General American Transportation

Ovens.....New catalog gives basic information about laboratory, pilot-plant and small batch-type production ovens. Includes dimensions, design data and prices.
146E Despatch Oven Co.

Plate Heat Exchanger.....Bulletin describes the new PL-1 plate heat exchanger, designed specially for laboratory use. Pictures and complete specifications.
146F De Laval Separator Co.

Power & Heating Unit.....New 3-pass power and heating unit with wet back construction is described in Bulletin B-3240. Certified results of operational tests.
146G Titusville Iron Works

Processing Ovens.....Bulletin describes line of industrial heat processing ovens. Both batch type and semiautomatic continuous ovens are covered. To 1,500 F.
146H Hevi-Duty Electric Co.

Steam Generator Development..... Recirculated gas, a major engineering development for obtaining proper proportioning of heat within a steam generator is topic of G-96.
146I Babcock & Wilcox

Steam Generators.....Bulletins describing Vogt boiler installations in a variety of industrial plants for power, processing & heating are available on request.
68 *Henry Vogt Machine Co.

Steam Traps.....Steam trap primer sets forth reasons for design of unique line of steam traps. Covers misconceptions that exist regarding steam traps and functions.
146J Barnes & Jones

Vaporizers.....Full technical information on vaporizers & the Heat Engineering service that goes with them is now available on your request.
97 *Foster Wheeler Corp.

Instruments & Controls

Air Sampling.....Leaflet discusses several methods for determining the amount and size distribution of airborne dusts. Available free on request.
146K Gelman Instrument Co.

Analog Computer.....Two-page brochure describes and illustrates the CM-2, a solid-state computing device for application in the process industries. Specifications.
146L So'west'n Indus. Electronics

Announciators.....New catalog of annunciator systems contains information on applications, engineering and mechanical details, etc. Related equipment covered also.
146M Panellit, Inc.

Computer Bibliography.....Booklet prepared for personnel trained for computer application covers Lists of indexes, bibliographies, periodicals and glossaries.
146N Remington Rand

Control Instrumentation.....Bulletin on electronic control for the process industries features illustrated chart on which all major system components are listed functionally.
146O Swartout Co.

Dial Thermometer.....Both vapor tension and gas-filled types are available in either distant reading or rigid stem types. Catalog available.
T138 *Marsh Instrument Co.

Flowmeter.....Bulletin covers new line of flowmeters that provide highly accurate and reproducible method of flow measurement for a wide variety of flow ranges.
146P Matheson Co.

Gage.....Ultransonic thickness gage to inspect ship hull plates, bulkheads, storage vessels, high pressure pipe, etc. Battery-operated. Descriptive literature offered.
125 *Sperry Products, Inc.

Gas Sampling.....Systems for sampling gases are described in new 8-page bulletin. Each system is divided into a possible total of eight component packages.
146Q The Hays Corp.

Hygrometrics.....Complete hygrometric catalog contains descriptions and illustrations of hundreds of detection, control and alarm equipment items. 69 pages.
146R American Instrument Co.

Indicators.....New Sight Flow Indicators are easily installed to show movement of liquid in pipe lines. For new or existing pipe line ½" to 2" N.P.T. Data Unit offered.
L152 *Jerguson Gage & Valve Co.

Indicators, Controllers.....Line of electric indicators and controllers for low-cost measurement and control is topic of new bulletin. Operating principles.
146S General Electric Co.

Level Control.....Electr-O-Probes are available in three models; B-04 super sensitive relay, B-05 general purpose relay, and B-06 self-contained. Bulletins.
B140 *Instruments, Inc.

Meter, Bellows.....Models are available in many ranges, for both flow & liquid level measurement & control. Details in reference data Catalog C22-1.
102-103 *Minneapolis-Honeywell

Meters.....Industrial pH meters, measure & control pH in industrial processes. Data File 14-49-06 contains a list of companies & instrument specifications.
47 *Beckman Instruments Inc.

Motor Controls.....New digest gives descriptive, pricing technical and engineering information on a complete line of motor controls. Available on request. 162 pages.
146T Allis-Chalmers Mfg. Co.

Plotters.....New literature gives detailed information on automatic multichannel and three-dimensional multichannel plotters. Prime current use in military plots.
146U Fenske, Fedrick & Miller

Radiation Instrumentation.....Equipment for onstream measurement of level, density or concentration; for fill controlling; for thickness inspection. Uses source plus detector.
146V Industrial Nucleonics

Recorder.....Transcope plug-in provides a complete cascade system. Gives continuous 30 day record. The unique set point transmitter allows continuous control. Catalog.
120-121 *Taylor Instrument Co.

Spectrochemical Instruments....."An Introduction to Emission Spectrochemical Instruments" describes operation, applications of manufacturer's equipment line.
146W Baird-Atomic

Speed Recorders.....Type HF differential speed strip-chart recorders for process equipment are discussed in new bulletin. Operation, general specifications, accessories.
146X General Electric Co.

Pipe, Fitting, Valves

Fittings.....Booklet on Fishmouth branch connection fittings covers cost comparisons, engineering design data points of practical use and major product benefits.
146Y H. K. Porter Co.

Industrial Hose.....Specifications, technical data, sizes, applications and installation information on line of hose and hose assemblies covered by catalog.
146Z Weatherhead Co.

Metal Hose Connections.....Equipped to work in stainless steel, Monel, and aluminum as well as other alloy steels and copper alloys. Further information.
51 *The American Brass Co.

Pilot Pipe .....includes a wide range of designs that handle a wide range of working pressures from 25 to 250 lbs. & also handle a wide range of chemicals & abrasives.
113 *United States Rubber

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* Don't forget to ask for your copy of this issue's free reprint feature (p. 104).

A filter man's thinking about missiles: How vulnerable is fuel purity control?

Today's missiles have prodigious appetites, exotic tastes . . . and delicate innards. The possible consequences of improper diet are alarming. The usual ration of liquid fuels — ultra-cold, explosively volatile — is tough to handle. But the fact is: fuel purity control has proved to be one of missilery's least vulnerable functions. Why? Largely because the humble filter has grown in stature lately.

We know. We make them.

We know it's no accident that filters are available to separate any particle larger than 10 microns from a torrent of corrosive 'LOX' —at –267°F. It's no accident that Purolator can offer industry a filter for liquid helium — to operate at –420°F and 10,000 psi — structurally rugged, compact, easy-to-clean. These are the fruits of years of research into extreme low temperature filtration. We anticipated defense and industrial needs...shaped yesterday's bold concepts into today's practical Purolator equipment. What kind of filters are these? No one kind, of course; they must be tailored to specific applications. But we're working with such media as

(1) frameless metal edge elements — exceedingly strong, unitized structures which we can make out of inconel, monel, platinum, tantalum, many stainless steels, etc. Such media can be operated through tremendous ranges — in some cases from –420°F to 1200°F...or where the temperature change is on the order of 300°/second. Built-in venturi action permits them to handle terrific volumes of fluids with extremely low differential pressures.

(2) fused, porous metal media — with remarkably uniform pore sizes ranging upward from a fraction of a micron.

(3) fibrous metallic media . . . exotic plastic materials of all kinds . . . combinations of these and the above.

We can't begin to tell you — in this column — about the full scope of Purolator's activity in liquid gas applications, or other areas that may interest you more. But our brochure called "New Roles for Filtration" makes good reading. And our "Filter Media Selection Chart"—giving corrosion and temperature factors for all known media — is a valuable reference to have on hand. Write us for either or both. They're yours for free.

Jules P. Kovacs

Jules P. Kovacs, V. P.

Filtration For Every Known Fluid

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PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

LITERATURE . . .

Saran Lined Pipe.....fittings, valves & pumps are available for systems operating from vacuum to 300 psi, from below zero to 200 F. More information on request.
33 *The Dow Chem. Co.

Seal Valves & Fittings.....Complete dimensional data and drawings for taper seal valves and fittings are covered in new catalog. Gives specific applications.
150A High Pressure Equipment

Valve.....New Type G Sleeveline is a non-lubricated plug valve. For sulfuric acid service, caustic service, solvent handling, etc., send for Bulletin V/12.
105 *The Duriron Company, Inc.

Valves.....Aloyco valves are supplied in such metals as 304 & 316 stainless steel, Aloyco 20, Nickel, Monel & Hastelloy B, C & D. Field consulting service available.
53 *Alloy Steel Products Co.

Valves.....Swivel disc saves seating surfaces in 18-8 SMo globe and angle valves. Complete specifications & recommendations on applications are available.
65 *Crane Co.

Valves.....Units operate freely under temperature - pressure extremes, with corrosive fluids & in any position. Available in 17 sizes. Booklet CE-119.
124 *Durabla Manufacturing Co.

Valves.....“Causul” Metal Valves hold up in corrosive service. Cuts plant maintenance costs. Further information in literature which is now available.
101 *The Lunkenheimer Co.

Valves, Jacketed Control.....apply heat uniformly throughout the valve from flange to flange & up to the stuffing box. Sizes from 1½” to 4”. Catalog 356-S.
150B Parks-Cramer Company

Valves, Safety-Relief.....Complete information is provided in Catalog FE-118, covering both selection & sizing of Farris process Safety-Relief Valves.
133 *Farris Engineering Corp.

Valves, Fittings, Piping, (Jacketed) . . . are covered in Catalog 356. It includes charts, diagrams, illustrations and other valuable information. Available on request.
150C Parks-Cramer Co.

Process Equipment

Acid Inhibitors.....A handy selection guide on Rodine Acid Inhibitors is offered. Helps you determine the proper class of inhibitors to use for various metals & cleaning media.
128 *Amchem Products, Inc.

Agitators & Mixers.....Turbine-type propeller (to 120” in tanks to 50’ dia.), slow speed, high speed, air lift, vertical turbine mixers, mixer-settler units. Bul. A2-B2.
136a *Denver Equip. Co.

Attrition Scrubbers.....High power input to efficiently remove sand coatings, mix dense slurries. Rubber lined or acid-proof tanks. Sizes to 56” x 56”. Bul. A-8505.
136b *Denver Equip. Co.

Ball & Rod Mills.....offer operation & convertibility. Wet or dry grinding systems. Sizes to 10’ x 20’. All steel construction. Bulletin B2-B20 sent on request.
136c *Denver Equip. Co.

Blowers.....operate at wider pressure & speed ranges than any other rotary positive blower. Capacities of 22 production models range from 50 to 4,000 CFM. Information.
126 *M-D Blowers, Inc.

Clarifiers.....Bulletin WC-123 contains drawings and data on the line of Rota-Rake clarifiers and thickeners. Bridge-supported and ceter-post designs to 150 ft.
150D Graver Water Conditioning

Crushing & Grinding.....Design provides easy access for cleanouts. Returns complete sample. Bulletin No. 067 gives full description of all laboratory machines.
144 *Sturtevant Mill Co.

Demineralizers.....are available in mono-column, dual-column & multi-column types . . . in flow rates from 10 to 10,000 GPH. Fifty standard models to choose from.
R152 *Penfield Mfg. Co., Inc.

Disc Separators.....assure positive length separation. Contain a series of discs mounted on a revolving horizontal shaft. Complete information.
135b *Sinmon-Carter Co.

Dryers.....Technical literature on pre-packaged vacuum tumble dryers available. Also details on the pre-testing facilities that are at your disposal.
20-21 *Patterson Kelley Co., Inc.

Dust Collectors.....The Dustex bulletin “A Simplified Test Method” describing actual collection test at your plant is now available on request.
B138 *Dustex Corp.

Dust Collectors.....Recent improvements in mechanical dust collectors, including a new involute design, are described in a technical bulletin. Illustrated.
150E Research-Cottrell, Inc.

Filter Cartridge.....offers increased solids capacity, lower pressure (which permits a higher filtrate rate), and more uniform performance. Full details.
119 *American Felt Co.

Filter, Vacuum.....The Bird Research and Development Center offers dependable pilot-scale test data. It takes up less space than ordinary drum filters.
2 *Bird Machine Co.

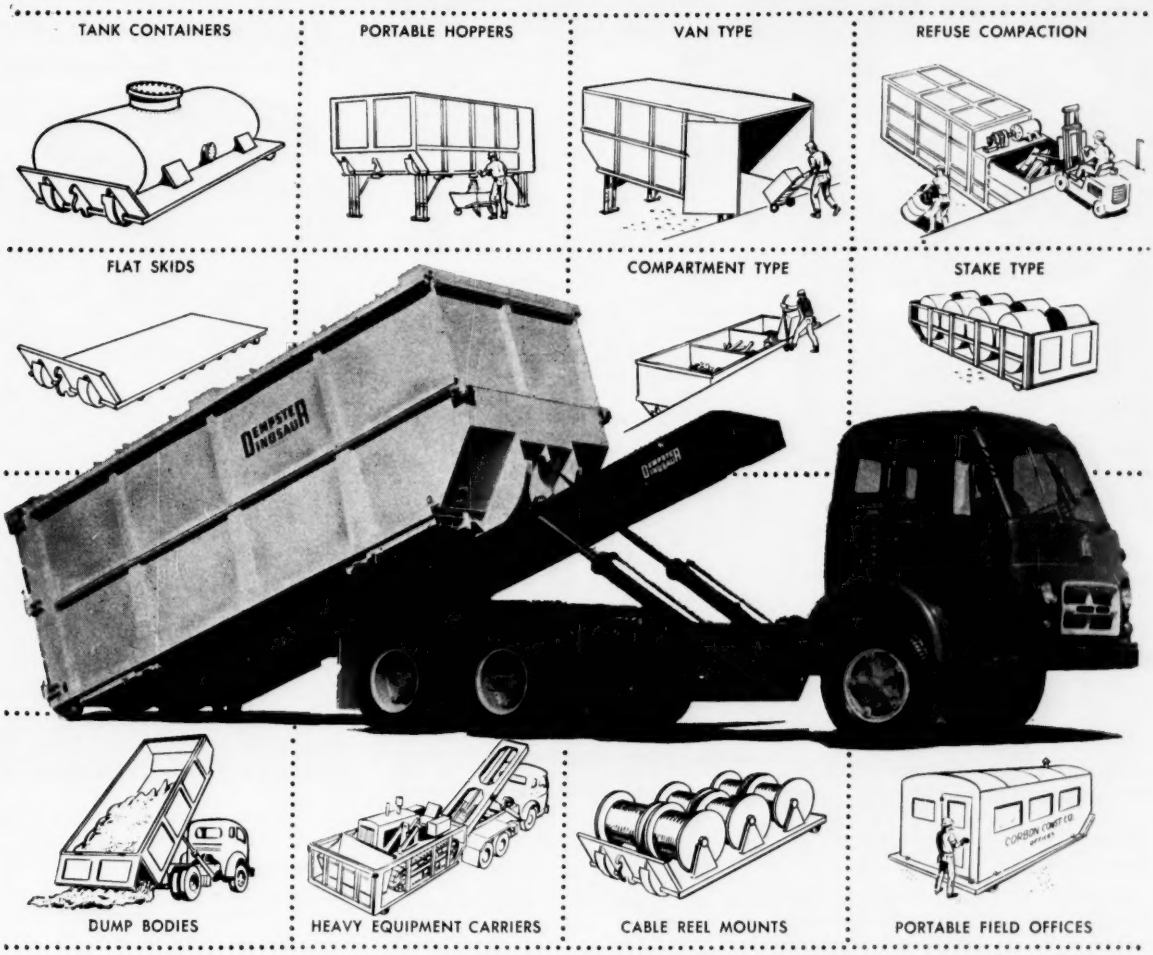
Filtration.....Brochure “New Rules for Filtration” & the “Filter Media Selection Chart” giving corrosion & temperature factors for all known media are offered.
150 *Purolater Products, Inc.

Glassed-Steel Storage Tanks..... Chemstor Glasteel tanks designed for corrosive or sticky products, or those that cannot tolerate contamination are topic of bulletin.
150F Pfaudler Co.

Jaw Crushers.....Cast steel frame, anti-friction side bearings & bumper bearings. Sizes from 2¼” x 3½” to 36” x 48”. Details in Bulletin C12-B12.
136d *Denver Equip. Co.

* From advertisement, this issue

One DINOSAUR With Detachable Containers Solves Many Complex Materials Handling Problems



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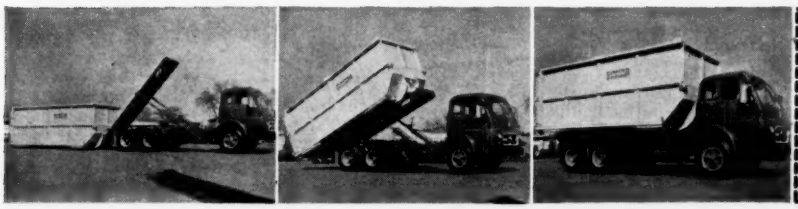

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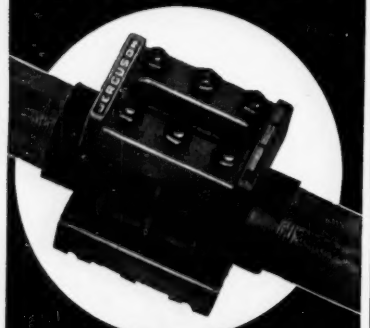

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Here is a new line of Sight Flow Indicators . . . easily and inexpensively installed in any new or existing pipe line ½" to 2" N.P.T.

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Jerguson Sight Flow Indicators are soundly designed, carefully made, and are backed up by a company with over 40 years experience in the field. Available in Transparent and Reflex types, in a wide variety of materials and linings, and with Wedge Type Illuminators, Haveg Chambers, Non-Frosting Glasses, or other special construction.

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LITERATURE . . .

Mixers.....Details of the new "5" size mixers are avaiable. Ratings range from 40 hp to 150 hp with double-reduction gearing, & from 10 to 50 hp with triple reduction.
166 *Mixing Equipment Co.

Precision Graders.....for sizing or separating free flowing granular materials by thickness. Complete information and descriptive folders on machines offered.
135a *Simon-Carter Co.

Process Equipment.....“Sub-A” Flotation is available in sizes from 16" x 16" to 72" x 72". Three types: “Cell-to Cell”; “Free-Flow”; Type “M”. Bul. F10-B86.
136f *Denver Equip. Co.

Process, Transportation Equipment.... Catalog covers services and products for process industries. Railway cars, field erection, gasholders, mixing devices, etc.
152A General America

Reagent Feeders.....Both wet & dry feeders available. Many standard units in stock. Bulletin F6-B8 containing more information is now available on request.
136e *Denver Equip. Co.

Rotary Airlock Feeders.....Bulletin P58 contains complete information on Rotary Airlock feeders for dust control and pneumatic conveying. Send for your copy.
T141 *Prater Pulverizer Co.

Samplers.....Continuous mechanical & automatic types for dry, solution or slurry sampling. Complete sampling plants & sample processing equipment. Bul. S1-B4.
136j *Denver Equip. Co.

Screens.....Bul. S3-B15 covers Denver-Dillon Screens for efficient wet or dry screening. Sizes to 6' x 14' in stock. Trommel Screens in sizes 30" x 60" x 120".
136k *Denver Equip. Co.

Spiral Rake Thickeners.....move settled materials to center in one revolution. Acid proof construction available. Bulletin No. T5-B6 is offered.
136l *Denver Equip. Co.

Turba-Film Processor.....features simplified installation, quality control, minimized cleaning, flexibility of use & uses less floor space. Bulletin 117.
16 *Rodney Hunt Machine Co.

Pumps, Fans, Compressors

Compressor.....The CRX carbon piston compressor does not require oil or water lubrication. Learn the details from Bulletin CRC-10. All types of compressors available.
130 *Gardner-Denver Co.

Compressors.....Dynamic compressors are available in sizes from 15 to 15,000 hp for handling air or gases. Complete information contained in Bulletin 922-11.
39 *Joy Mfg. Co.

Compressors.....Oil-Free Compressors feature chrome-plated cylinder walls. Resists corrosion & gives extra wear. Complete details in Bulletin 926-11.
41 *Joy Manufacturing Co.

* From advertisement, this issue

Need Ultra-Pure Process, Make-Up or Rinse Water?

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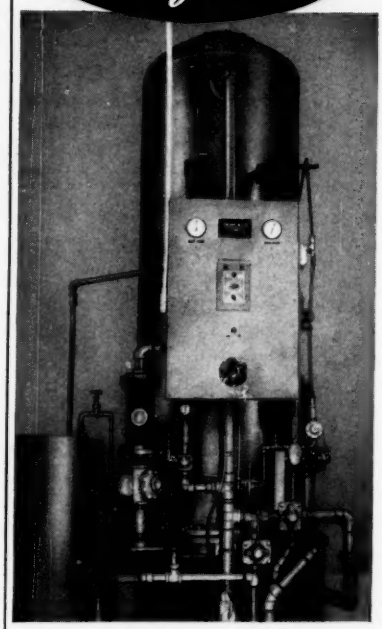

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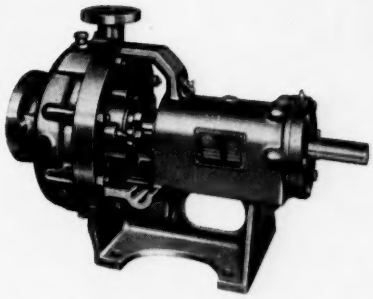

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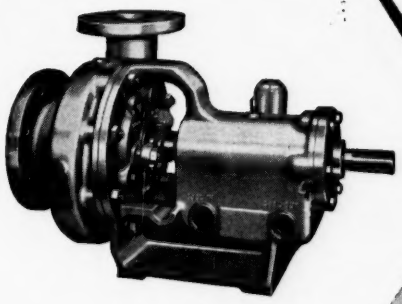

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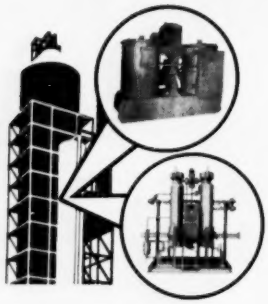

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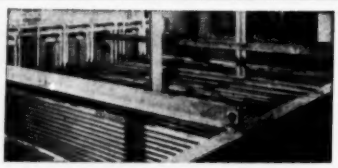

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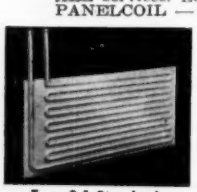

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LITERATURE . . .

Elbow Fans.....Bulletin VEF-59 covers elbow fans for ventilation, oven, dryer and kiln application. High efficiency with minimum turbulence and noise. Illustrated.
154A L. J. Wing Mfg. Co.

Explosions in Compressor Systems..... Bulletin 173 presents findings on the mechanism of explosions in pipelines and compressor starting air lines. Prevention methods.
154B Clark Bros. Co.

Industrial Fans.....Fundamental data relating to capacities and construction of the Type I. E. line of industrial fans are topic of bulletin. Complete rating tables.
154C Lehigh Fan & Blower

Process Compressors.....Bulletin 160 presents information on heavy-duty, balanced/opposed compressors for the process industries. Includes specifications, design.
154D Clark Bros. Co.

Pump.....New positive displacement handles without turbulence, pulsation, aeration or agitation, corrosive-problem liquids of high or low viscosity. Catalog P 302.
89 *Waukesha Foundry Co.

Pump, Fire.....Brochure lists the outstanding features and the condensed specifications of the model 2F7 Portable Fire Pump. Only 50 lbs. complete with engine.
154E Goodyear Pumps Inc.

Pump Seals.....Bulletin describes some common causes of failure of mechanical seals on pump shafts in water systems, and gives corrective information.
154F Water Service Laboratories

Pumps.....SRL (Rubber Lined) pumps offer high efficiency, low horsepower. Sizes to 5000 g.p.m. Additional information in Bulletin P9-B10.
136i *Denver Equip. Co.

Pumps.....Type DM with capacities up to 1000 GPM, head range up to 430 feet, working pressure up to 300 PSIG & temperature range up to 450 F. Bulletin No. B-1608.
153 *Food Mach. & Chem. Corp.

Pumps, Acid.....Pumping parts are available in a variety of metal alloys, as well as plastic, to cover a wide range of corrosive applications. Details.
165 *A. R. Wilfley & Sons, Inc.

Pumps, Diaphragm.....Sizes 1" to 10" simples and duples, capacity to 1000 g.p.m. Stroke can be adjusted while pump is operating. Details in Bul. P8-B12.
136g *Denver Equip. Co.

Pumps Turbine.....Descriptions and illustrations of features incorporated in a new line of turbine type pumps is subject of bulletin S-111. Specifications.
154G Aurora Pump Div.

Pumps, Vertical Centrifugal.....for handling frothy liquids or coarse, sandy slurries, constant or intermittent flow. Capacity to 450 g.p.m. Bul. No. P10-B5.
136h *Denver Equip. Co.

Services & Miscellaneous

Corrosion Resistance.....New booklet, "Engineering Properties of Ni-O-Nel," explains how to handle severely corrosive hot acids and oxidizing chemicals.
154H International Nickel Co.

Dust Collecting Systems.....cyclones with exclusive Shave-off trap extra % of dust. Systems described in booklet "Collection & Recovery of Industrial Dusts."
134 *Buell Engineering Co., Inc.

Fabrication.....of reactors, pressure vessels, vacuum tanks, etc. Newly published, easy-to-read, illustrated booklet, "Facilities and Products" is available.
64 *Newport News Shipbuilding

Fire Fighting Products & Systems..... Foam and FogFoam fire protection systems meet the needs of every type of oil & gas installation. Details on request.
107 *Rockwood Sprinkler Co.

Foam Problems.....A complete story on industrial foaming problems is presented in publication CDS-204. What causes foaming, control of foaming explained. Illustrated.
154I General Electric Co.

Gold Plating Formulations.....New 7-page technical paper covers metallurgical properties & applications for low pH acid-type gold plating formulations trademarked Karatclad.
154J Sel-Rex Corporation

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154K Industrial Models, Inc.

Irradiation Service.....Bulletin covers facilities for handling complete radiation effects programs, from planning through irradiation and post-irradiation analysis.
154L General Electric Co.

Radiation Sageguards.....8 p. "Bio-Assays for Hazard Control" describes program company offers to continuously assess hazards to personnel in operations involving radioisotopes.
154M Controls for Radiation, Inc.

Radiation Safeguards.....4 p. "Advanced Film Badge Dosimetry" described company's film badge service for firms whose personnel may be harmed by ionizing radiation.
154N Controls for Radiation, Inc.

Radiography, Industrial.....12 p. booklet describes equipment and methods of radiographing all kinds of industrial products, selection of proper isotopes for a job.
154O Picker X-Ray Corp.

Radiometric Analysis.....4 p. bulletin 6 describes how to make quantitative determinations by radiometric analysis. Sketches give examples of analysis.
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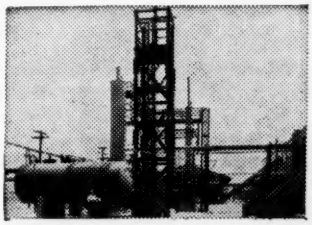

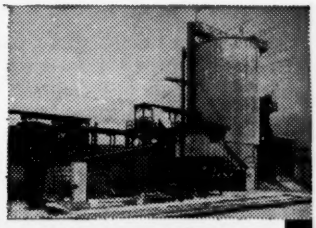

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15—Storage Tanks: 3800; 6000; 9000; 10,000; 15,000; 47,000 gals.

MISCELLANEOUS

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1—7500 gal. 316 S.S. Vert. Storage Tank, 7'x25', 50 PSI.
1—750 gal. nickel clad Mixing Tank, 125# nickel coils.
1—4000 gal. Haveg Vert. Tank, 8'x12'.
1—1500 gal. Stainless Pressure Tank, 90#.
1—12,000 gal. horiz. steel Pressure Tank, 7'6"x36', 200 PSI.
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1—Bird 18"x28" 316 S.S. Solid Bowl, Continuous.
1—Bird 18"x28", steel, Solid Bowl, NEW, Continuous.
1—Bird 36"x50", 347 S.S. Solid Bowl, Continuous.
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1—Sharples H2 Nozzlejector, 15 HP, 304 S.S.
1—Bird 40" suspended, 347 S.S. perforated basket.
2—Sharples #16, 304 S.S., 3 HP motor.

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1—#12 Sturtevant 304 S.S. Rotary Mixer, 450 cu. ft.
1—Baker Perkins #16TRM, 150 gal. jktd., Vac. 60 HP.
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1—Louisville 54" x 35', Monel Rotary Steam Tube Dryer.
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1—Devine Vacuum Shelf with 19 - 59" x 78" shelves.
1—Devine Vacuum Shelf with 10 - 40" x 43" shelves.
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2—Devine 5' x 12', 4' x 9', single drum, atmospheric.
1—Baker Perkins 5'6" x 6' Rotary Vacuum Dryer.
1—Buflovak 3' x 20' Rotary Vacuum Dryer, 316 S.S. Unused.
2—Louisville Rotary Steam Tube 6' x 25', 6' x 50'.
4—Rotary Dryers, 4' x 40', 6' x 50', 7' x 80'.
2—Louisville 8' x 50' Stainless Steel Lined Rotary Dryers.
1—Traylor 30" x 18' Stainless Steel Rotary Dryer.
2—Link Belt; 7'5" x 25", 6'4" x 24', S.S. Louvre Dryers.

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1—Oliver 3' x 6' Steel Rotary Vac. Precoat Filter.
1—Niagara #370-38 Filter, 370 sq. ft., 304 S.S.
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1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaporite housing.
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12—4500 gal. nickel-clad, vert. 125#.
1—3000 gal. alum., vert., open.
1—10,500 gal., T304 SS, horiz., UNUSED, dished heads.
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25—Copper & Cupro-Nickel heat exchangers & condensers, up to 1070 sq. ft.

TYPE 316 SS KETTLES

1—3,500 gal. Struthers-Wells vert., 7' dia. x 12" high, jacketed, int. coils, 40/20 HP agit.
1—2,830 gal. horiz. still kettle, 6' x 12' 100 sq. ft. int. coil.
2—2,250 gal. vert., 7' dia. x 6'3" high, jacketed, 3 HP agit.
1—2200 gal., 6'6" x 8', vacum, jacketed, agit, T316 SS.

TYPE 316 STAINLESS STEEL PRESSURE TANKS

1—17,650 gal. horiz., 9' dia. x 36' long, 1/4" shell, 3/8" dished heads, 40# WP
1—2,830 gal., horiz., 6' x 12', 5/16 shell & dished heads, VACUUM, or 80# WP
3—2,750 gal. vert., 7' x 8', dished heads, int. coils, 50# WP
9—2,600 gal. vert., 7' x 8', int. coils, (some w/agit), 19# WP
5—2,250 gal. vert., 7' x 6'3", dished heads, (some w/agit., some w/jacket), 70# WP
2—1,900 gal. vert., 6' x 8', 3/8" shell & dished heads, VACUUM, or 100# WP
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6—685 gal. vert., 3' x 13', internal coils.
1—575 gal. vert., 4' x 6', dished heads, 90# WP, 355 sq. ft. int. coils.
50—Tanks & pots, 30 to 500 gal., T 316 SS.

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1—110" dia. Vulcan, 10 trays—bubble caps, T316 SS.
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1—96" dia. Vulcan, 10 trays—bubble caps, T316 SS.
2—60" dia. Vulcan, 10 trays—bubble caps, T316 SS.
1—48" dia. Vulcan, 25 trays—bubble caps, T304 ELC SS, 100 PSI.
3—24" dia. Vulcan, 12 trays—bubble caps, T316 SS—VACUUM.
6—T316 SS Packed Columns: 42", 36", 30" dia.
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2—Stainless steel reboilers.
2—Stainless steel bucket elevators, 60' & 40' high.
1—2,100 gal. vert. alum. tank, coils.
10—T316 SS separators, 22" x 8' deep.
1—2,000 gal. copper tank.
3—18,000 gal. steel tanks.

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1—Pfaudler 200 gal. glass lined reactor with impeller type agitator and drive.
1—Process Engineering SS jacketed reactor, 1500 gal., 140# W.P. jacket, 150# W.P. shell
1—Tolhurst 40" suspended type heresite lined centrifuge with perforated basket complete with motor and plow

AUTOCLAVES, KETTLES, AND REACTORS

1—Allied Steel Products type 316 SS jacketed reactor, 750 gal.
3—Type 316 SS 150 gal. jacketed reactors, complete with agitators and drives
1—Steel and Alloy Tank Co. 100 gal. type 347 SS pressure tank, 250 psi. jacket
1—Blaw-Knox 400 gal. steel jacketed autoclave, 570# internal pressure, 85# jacket
1—Blaw-Knox 45 gal. jacketed autoclaves, 1500# pressure
1—Pfaudler 500 gal. glass lined jacketed reactor, complete with impeller type agitator, baffle and drive
1—Struthers Wells 500 gal. nickel jacketed reactor.
1—Patterson-Kelley 6000 gal. steel jacketed reactor, 40# jacket, complete with agitator and drive
1—Patterson 2000 gal. steel jacketed reactor
28—30,000 gal. steel vertical storage tanks

DRYERS

1—Link Belt steel roto louver dryer, Model 1003-30
3—Link Belt steel roto louver dryers, Model 207-10, 310-16, 604-20
1—Buflovak double drum dryer 42" x 120"
3—J. P. Devine single door vacuum shelf dryers, 20, 17 and 12 shelves
1—Stokes stainless steel rotary vacuum dryer, 2' x 6'
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
1—Stokes double drum dryer, 5' x 12'
1—Louisville rotary steam tube dryer, 8' x 45'
2—Louisville SS rotary dryers, 8' x 50'
1—Louisville SS rotary kiln, 30" x 28' complete
1—Louisville rotary dryer, 38" x 40', Type L
1—Ruggles Coles 4' x 30' rotary kiln
1—Traylor 4' x 40' rotary dryer
1—Rotary dryer, 6' x 36'

FILTERS

3—Dorrco rubber covered filters, 6' x 2'
1—Sweetland #3 stainless steel filter
1—Niagara SS filter, Model 510-28
1—Oliver horizontal filter, 3'
10—Shriver plate and frame filter presses, 12" to 42"
1—Shriver C.I. plate and frame filter press, 36" x 36" closed delivery, 4 eye, 60 chambers
1—Shriver rubber lined filter press, 36" x 36"
12—Sweetland #12 filters with 72 SS leaves

CENTRIFUGES

1—Tolhurst SS 20" suspended type centrifuge with perforated basket, complete with plow and motor
1—AT&M 26" suspended type centrifuge with SS perforated basket, complete with plow and motor
1—AT&M 48" SS suspended type centrifuge, complete with plow, motor and imperforate basket
1—Bird type 316 SS centrifuge, 32" x 50"
4—Tolhurst 30" center slung rubber covered centrifuges with perforated baskets and motors

THE GELB GIRL—NOVEMBER 1959

MIXERS

15—Robinson type 304 SS horizontal blenders, 255 cu. ft. each
3—Robinson type 316 SS sigma blade jktd. H.D. mixers, 400 gal.
1—Baker Perkins Size 6, double arm vacuum mixer, 2¼ gal. cap.
1—12' x 4' pug mixer, type 316 SS
1—Patterson type 347 SS jacketed vacuum sigma kneader master, 500 gal.

MISCELLANEOUS

1—Cleaver Brooks 500 HP package steam generator, 200#
1—Ames 300 HP package steam generator, 150#
2—Cleaver Brooks package steam generators, 50 & 80 HP, 125#
2—Heat Transfer Products steel bubble cap columns, 36" and 42" with 5 and 10 trays
1—Acme steel bubble cap column, 42" dia. with 10 trays
2—Patterson-Kelley steel heat exchangers, 1000 sq. ft. each
6—Struthers Wells heat exchangers, 885 sq. ft.
1—Patterson-Kelley steel heat exchanger, 427 sq. ft.
50—Steel heat exchangers from 15 sq. ft. to 400 sq. ft.
25—Davis Eng. SS heat exchangers, 145 and 230 sq. ft. (NEW)
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
2—Condenser Service type 316 SS heat exchangers, 350 sq. ft.
3—Badger type 316 SS heat exchangers, 500 sq. ft. and 600 sq. ft.
1—Badger type 316 SS bubble cap column, 42" dia. with 11 trays
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Vulcan SS bubble cap column, 4' x 28 plates
3—Robins shaker screens, SS, 3' x 6'
1—Swenson type 316 SS vacuum crystallizer, 3'6" x 12'
1—Swenson type 316 SS vacuum crystallizer, 2' x 12'
1—Blaw Knox steel distillation column, 36" x 40', 24 trays (NEW)
3—Williams type 316 SS hammermills, Model AK
1—Stokes Model 8 tablet press
1—Swenson SS pilot plant spray dryer

2—Sturtevant #7 SS dust type rotary batch blenders, NEW
1—Oliver SS rotary pressure precoat filter, 5'3" x 8'
4—Stokes Model 138J-20 single door vacuum shelf dryer, 20 shelf
1—Baker Perkins Size 16 Type UUEM 150 gal. jacketed double arm dispersion type mixer, complete with compression cover and 100 HP motor.

Established 1886

R. GELB & SONS, Inc.,

CHEMICAL, RUBBER, OIL, PLASTIC and FOOD PROCESSING MACHINERY

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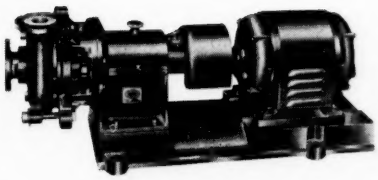

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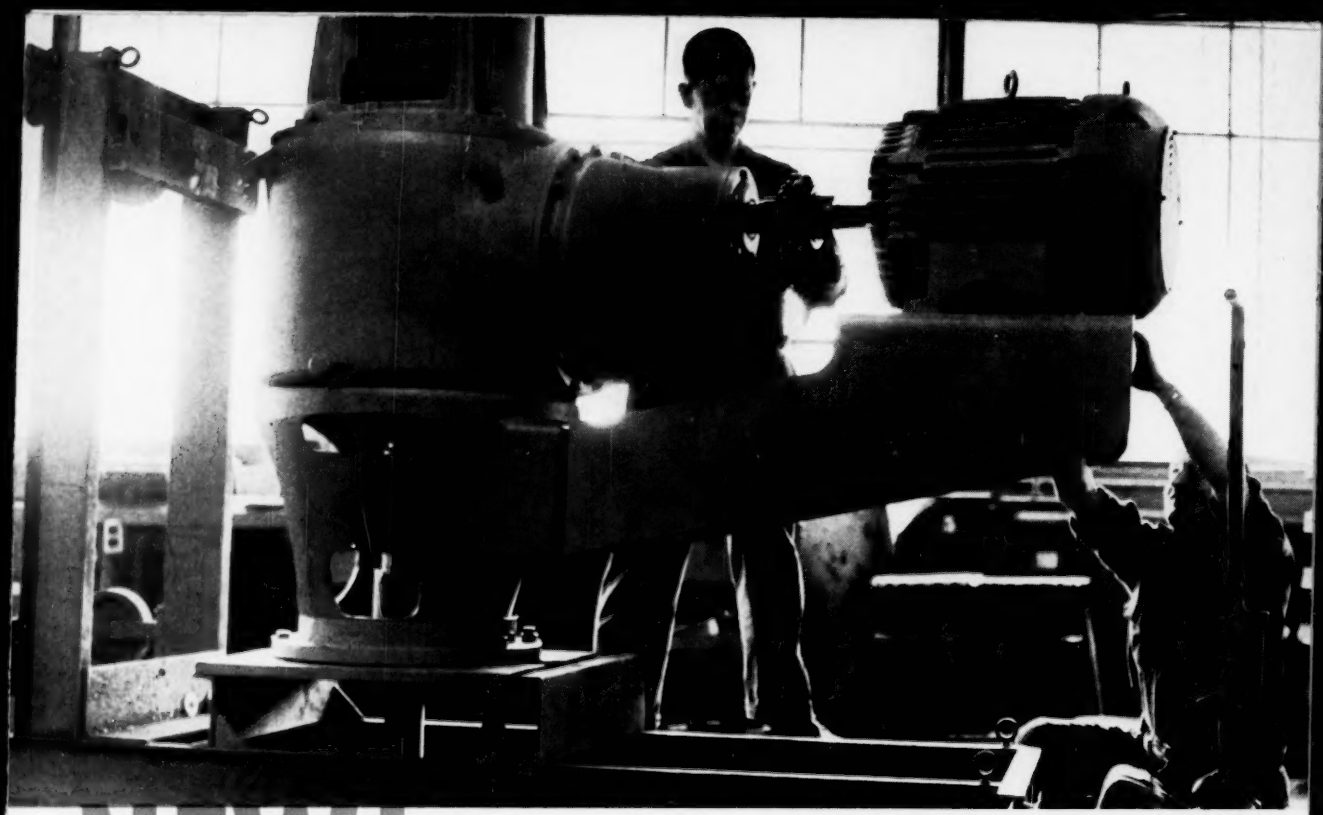

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Instead of waiting months, you can now have one—or several—ready to put on your tanks *in a few weeks!*

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4. Positive splash lubrication.
5. Complete weatherproofing protection.

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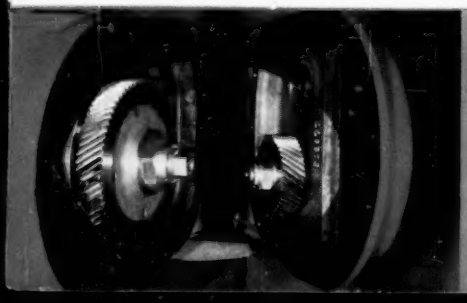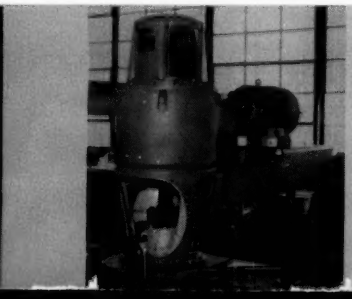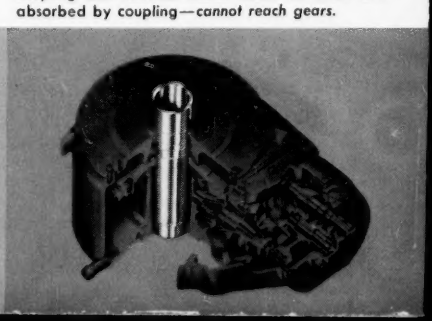
MIXER SHAFT FLEXIBLY COUPLED TO SPEED REDUCER. Mixer shaft passes through hollow quill. Shaft and quill are connected only by a flexible coupling (not shown). Shock loads on shaft are absorbed by coupling—*cannot reach gears.*